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# The Roentgen Anatomy of the Skull in the Newborn Infant[1]

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IN ORDER TO learn more of the normal and of normal variations, the skulls of 100 infants were examined roentgenologically. Many of the landmarks so familiar in the adult do not appear in the infant, and similarly the common appearance of the infant's skull is no longer present in the older person. By a comparison of the infant's roentgenograms with the actual skull of the newborn, many of the structures observed on films can be identified. The major purpose of this paper is to indicate these points of interest.

*Embryology of the Skull* (1, 3, 4). The difference in appearance of the infant's skull from that of the adult can be appreciated better by a brief review of the embryological development. The earliest evidence of the cranium is found in dense masses of mesenchyme which embrace the cranial end of the notochord as the parachordal plates and extend into the primitive ethmoid region as the trabeculae cranii. Dense mesenchyme also encloses the auditory, nasal, and optic centers. In the basisphenoid and basioccipital and around the auditory vesicles there is found the first evidence of the intracartilaginous skull. The developing mesoderm grows from these areas around the brain until the latter is enveloped by the membranous cranium. The primitive cranial foramina are left when the developing cranial membrane grows around the cerebral nerves.

Approximately at the beginning of the second month, fusion of the mesenchymatous elements takes place, followed by cartilage formation, resulting in the formation of the primitive base of the cranium. Cartilage also forms around the auditory and olfactory primary centers. In the beginning this cartilage is widely separated from that of the base of the cranium. By the time the fetus is approximately forty-five days old, however, the auditory capsule has fused with the basal cartilage. A broad, thin cartilaginous plate grows from the lateral region of the occipital cartilage around the lower portion of the brain to form the early foramen magnum.

The entire fused cartilaginous area is known as the chondrocranium. In it various centers of ossification begin to appear, and it is converted almost entirely into bone. The chondrocranium, however, is continuous with the cranial vault, and consequently some of the skull bones are of both cartilaginous and intramembranous origin. On the other hand, the bones of the cranial vault, the vomer, and the bones of the face are entirely of intramembranous

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TABLE I: EMBRYOLOGY OF THE SKULL (1, 3, 4)

| Skull Bones | Number in Skull | Number of Ossification Centers for Each Bone | Remarks |
|---|---|---|---|
| BONES OF PURELY MEMBRANOUS ORIGIN | | | |
| Parietal | 2 | 1 | 1 center on either side of mid-sagittal plane |
| Frontal | 1 | 2 | |
| Nasal | 2 | 1 | Centers of ossification arise in mesenchyme of facial region |
| Lacrimal | 2 | 1 | |
| Zygomatic | 2 | 1 | |
| Vomer | 1 | 2 | Centers arise in connective tissue on either side of inferior end of lamina perpendicularis of ethmoid |
| Maxilla | 2 | 2 | The first branchial arch bifurcates to form |
| Palate | 2 | 1 | (*a*) the superior maxillary process (in which the palate and maxillary bones develop in membrane) and<br>(*b*) the inferior mandibular process (the mandible of intramembranous origin developing herein as paired centers of ossification lateral to the body of Meckel's cartilage, this cartilage forming the axis of the mandibular process of the first branchial arch) |
| COMPOUND BONES (FORMED CHIEFLY IN CARTILAGE BUT PARTLY IN MEMBRANE) | | | |
| Occipital | 1 | 9 | (*a*) Cartilaginous origin<br>(1) Basilar part (1 center)<br>(2) Lateral parts (1 center for each)<br>(3) Supra-occipital part (the squama below the superior nuchal line) (4 centers, 2 on either side of mid-line)<br>(*b*) Intramembranous origin<br>(1) Interparietal part (the squama above the superior nuchal line) (2 centers, 1 on either side of mid-line) |
| Sphenoid | 1 | 18 | (*a*) Cartilaginous origin<br>(1) Body (2 centers in presphenoid portion, 2 in basisphenoid portion, and 1 in each lingula)<br>(2) Greater wing (1 center in each)<br>(3) Lesser wing (1 center in each)<br>(*b*) Intramembranous origin<br>(1) Orbital and temporal margins of greater wing and medial portion of each pterygoid process (except the hamular process) (4 centers on each side) |
| Temporal | 2 | 5 | (*a*) Cartilaginous origin<br>(1) Petrous. A complete bony capsule results from fusion of several centers of ossification which fuse early, the capsule enveloping the inner and middle ear. Mastoid process formed postnatally from petrous<br>(2) Tympanic. Formed by ossification of cartilage around inner end of external auditory meatus<br>(3) Tympanohyal and<br>(4) Stylohyal. These develop from cartilage formed from visceral arches. They unite to form the styloid process<br>(*b*) Intramembranous origin<br>(1) Squamous. Arises from lateral wall of primitive cranium |

*Table cont. on opposite page*

origin, and ossification occurs directly in the membrane.

In an attempt to show more clearly the manner in which the skull develops, it seems advisable to present some of the facts in tabular form (Table I).

TABLE I: EMBRYOLOGY OF THE SKULL—*cont.*

| Skull Bones | Number in Skull | Number of Ossification Centers for Each Bone | Remarks |
|---|---|---|---|
| BONE OF CARTILAGINOUS ORIGIN | | | |
| Ethmoid | 1 | 5 | (*a*) Mesial mass of cartilage extending from tip of nasal process to sphenoid. Terminal part persists as cartilaginous nasal septum. Ossification of upper portion forms perpendicular plate and crista galli<br>(*b*) A pair of cartilaginous masses lateral to the olfactory sacs ossify into spongy bone of ethmoidal labyrinths. Resorption of this bone and invagination of nasal mucous membrane produce nasal turbinates and ethmoidal cells<br>(*c*) Cartilaginous trabeculae surrounding olfactory nerve fibers lateral to mesial mass of cartilage connect the mesial and lateral masses. These trabeculae ossify, forming the cribriform plates |

*The Skull at Birth:* Schüller (7) quotes Mueller to the effect that under certain conditions a change in the skull shape is brought about in intrauterine life through the pressure of the uterine wall resulting from scanty amniotic fluid, and through the long-continued resting of the head upon the pelvic inlet. Labor produces a further remodeling of the head. Schüller also states that for every fetal position there is a characteristic molding of the skull. He writes that the skull born with an occipital or face presentation is a long skull; that born with frontal presentation a high skull; that born with vertex presentation a short skull. This author believes that these varieties of skull shapes have existed in less pronounced degree before birth, and that they decisively influence the position of the head in its passage through the pelvis.

Moloy (5) discusses the changes which take place in the fetal skull during labor as a result of molding, with particular stress on changes in the base of the skull. He believes that in the process of molding there is locking of the frontal and parietal bones at the coronal suture and, to a less marked degree, of the occipital and parietal bones at the lambdoid suture. Compensating changes at the base, consisting of elevation of the occipital region with bending at the sphenopetrous angle, take place. As a result, bending and displacement are permitted by the above method of locking. Moloy says further that at birth, both in the molded head and in the head delivered by cesarean section, the coronal and lambdoidal suture lines are either closed or show very slight separation. A separation at these suture lines begins shortly after birth and increases rapidly in the postnatal period.

The greatest length of the skull is defined by Schüller (7) as the distance from the most remote point of the occiput to the forehead, the greatest breadth as the distance between the opposite points of the temporal region most distant from one another, and the greatest height as the distance from the anterior edge of the foramen magnum to the highest point of the vertex. Neumayer, quoted by Schüller, found that at birth the post-auricular part of the cranium is larger than the pre-auricular portion.

A comprehensive description of the general roentgen appearance of the skull in the newborn is given by Pancoast, Pendergrass, and Schaeffer (6). They note the disproportionately large size of the skull at birth in comparison with the body, and the predominance of the cranial over the facial portion, with a ratio of eight to one. In discussing the development of the skull, these authors comment on the absence of mastoid processes as such at birth, while the maxillary and

TABLE II: EXPOSURE FACTORS IN EXAMINATION OF THE NEWBORN SKULL

| Views Made | Average Measurement in Centimeters | Kv.P. | Ma. | Time in Seconds | Target-Film Distance in Inches | Screens | Bucky |
|---|---|---|---|---|---|---|---|
| P.A. (Nose-Forehead) | 12 | 63 | 480 | 1/20 | 36 | Par speed | Yes |
| P.A. (Waters) | 13 | 69 | 480 | 1/20 | 36 | Par speed | Yes |
| Occipital | 13 | 69 | 480 | 1/20 | 36 | Par speed | Yes |
| Base | 13 | 71 | 480 | 1/20 | 36 | Par speed | Yes |
| Lateral | 10 | 53 | 480 | 1/20 | 36 | Par speed | Yes |
| Mastoid (Lateral) | 12 | 60 | 480 | 1/20 | 36 | Par speed | Yes |

ethmoid sinuses are partially developed. The frontal sinus is present only in rudimentary form in the anterior ethmoidal area, while the sphenoid sinus is very small and pneumatization of the sphenoid bone has not yet begun.

## PRESENT STUDY

In the present study roentgenograms were made of each infant in (1) the postero-anterior or nose-forehead projection, (2) the maxillary sinus or Waters' position, (3) the occipital, (4) the lateral, and (5) the base or mento-vertical projections. In addition, roentgenograms in the lateral mastoid position were made in approximately one-fourth of all the infants studied. The head was held in position by means of a non-opaque cellulose sponge, so constructed as to form a semicircle which could be placed partially encircling the skull. The technical factors are given in Table II.

An attempt was made to select only healthy infants for this investigation, any with obvious abnormalities being excluded. In general the mothers were also free from disease. In those cases in which there was a history of maternal disease, it was considered to be of the type that would not affect the development of the child *in utero*. This statement is made with reservations in view of the presence of a weakly positive Wassermann reaction in two mothers. Pertinent facts relating to the mothers are given in Table III.

TABLE III: DATA PERTAINING TO THE MOTHERS OF 100 NEWBORN INFANTS

| | Cases |
|---|---|
| **BLOOD SEROLOGY** | |
| Negative | 93 |
| Positive (1 plus) | 2 |
| Unrecorded | 5 |
| **MATERNAL MEDICAL HISTORY** | |
| Primipara | 34 |
| Multipara | 66 |
| No previous significant illness | 80 |
| Pre-eclamptic toxemia | 4 |
| Simple hypertension | 5 |
| Treated syphilis | 3 |
| Rheumatic heart disease | 2 |
| Miscellaneous (hay fever, tubo-ovarian disease, "nervous breakdown," cystitis, pneumonia, questionable tuberculosis) | 6 |
| **TYPES OF PELVES** | |
| Gynecoid | 89 |
| Android | 4 |
| Anthropoid | 1 |
| Platypelloid | 5 |
| Unrecorded | 1 |
| **METHOD OF DELIVERY** | |
| Spontaneous | |
| Breech | 1 |
| Vertex | 76 |
| Low forceps | 14 |
| Version and extraction | 4 |
| Cesarean section | 5 |

LENGTH OF LABOR: Range in hours, 1–80

The infant birth weights varied from 5 pounds, 1 ounce, for an infant who was four weeks premature, to 9 pounds, 4 ounces, for a full-term child. Normally the incidence of births of white babies in this hospital is greater than that of colored, but in this group 61 were colored and 39 white. The female babies were in the majority, numbering 53, only 47 being males. The ages of 95 ranged from one to ten days, only 5 being between ten and fourteen days of age at the time of the

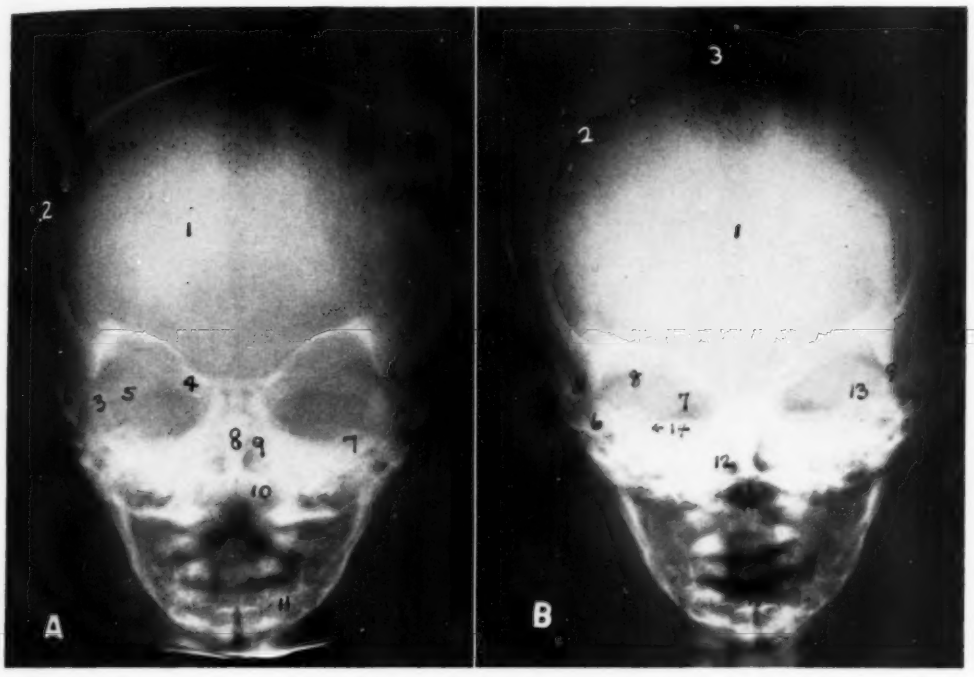


Fig. 1. Postero-anterior view of skull of newborn, nose-forehead position.

A. 1. Frontal. 2. Parietal. 3. Zygoma, frontal process. 4. Sphenoid, lesser wing. 5. Sphenoid, greater wing. 6. Temporal, squamous portion. 7. Petrous pyramid. 8. Nasal septum. 9. Turbinate. 10. Maxilla. 11. Mandible.

B. 1. Metopic suture. 2. Coronal suture. 3. Sagittal suture. 4. Anterior fontanelle. 5. Antero-lateral fontanelle. 6. Squamo-sphenoidal suture. 7. Sphenoidal fissure. 8. Spheno-frontal fissure. 9. Zygomatico-frontal suture. 10. Intermaxillary suture. 11. Intermandibular suture. 12. Naris. 13. Arcuate eminence. 14. Superior semicircular canal.

roentgen examination. The period of gestation in 89 cases was nine months. Ten of the babies were two to four weeks premature, the remaining infant being born at the end of seven and a half months' gestation. These data are presented in summary in Table IV.

*Skull Measurements:* Various diameters of the skull were measured in an attempt to establish a standard for the newborn. As Moloy (5) has indicated, many of the cephalic diameters are changed during molding of the fetal skull, although the total volume may be unaffected. However, even in extreme molding this author says that the mid-petrovertical diameter remains constant.

In the study of this group of infants anteroposterior and vertical height measurements were determined for the hypophyseal fossa. The greatest anteroposterior or occipitofrontal diameter, the greatest breadth, and the greatest height from the foramen magnum to the vertex of the skull were measured. If Schüller's (7) statement has been interpreted correctly, he

TABLE IV: DATA PERTAINING TO 100 NEWBORN INFANTS

| | |
|---|---|
| BIRTH WEIGHT | 5 lb. 1 oz. to 9 lb. 4 oz. |
| RACE | |
| White | 39 |
| Colored | 61 |
| SEX | |
| Male | 47 |
| Female | 53 |
| AGE | |
| 1–10 days | 95 |
| 11–14 days | 5 |
| PERIOD OF GESTATION | |
| Full-term | 89 |
| Premature, 2 to 4 weeks | 10 |
| Premature, 6 weeks | 1 |


Fig. 2. Postero-anterior view of skull of newborn, maxillary sinus position.

A. 1. Frontal. 2. Zygoma. 3. Arch of zygoma. 4. Sphenoid, body. 5. Sphenoid, greater wing (posterolateral orbital wall). 6. Temporal, squamous portion. 7. Temporal, petrous portion. 8. Maxilla. 9. Nasal. 10. Nasal septum. 11. Parietal. 12. Mandible. 13. Occipital, squamous portion. 14. Occipital, basilar portion. 15. Occipital, right lateral portion. 16. Foramen magnum.

B. 1. Metopic suture. 2. Zygomatico-frontal suture. 3. Zygomatico-maxillary suture. 4. Squamo-parietal suture. 5. Squamo-sphenoidal suture. 6. Lambdoid suture. 7. Coronal suture. 8. Inter-mandibular suture. 9. Spheno-occipital suture. 10. Anterolateral fontanelle. 11. Infra-orbital foramen. 12. Foramen ovale. 13. Mastoid antrum. 14. Fenestra vestibuli. 15. Porus acusticus internus.

takes the greatest breadth of the skull to be in the bitemporal diameter. In this group, the greatest breadth was found to be in the biparietal diameter, and measurements of the skull were made accordingly. Multiplication of the length, height, and breadth gives a figure which may be taken to represent roughly the skull volume. This, of course, is not the true skull volume, but, as will be seen, the figure obtained is satisfactory for comparison with the birth weight.

Anteroposterior diameters of the sella turcica varied between 4.0 and 6.5 mm., the average figure being 5.2. In depth, the range was between 1.5 and 3.5 mm., with an average of 2.5. Considerable variation was noted in the occipitofrontal diameter, the breadth, and the vertical height of the skull in different infants. The average vertical height was 10.18 cm., the average occipitofrontal diameter, 12.5 cm., and the average breadth, 10.2 cm. The average figure for the approximate skull volume, as determined above, was 1,275 c.c. As will be noted in Table V, there is only a slight difference in these average figures for the colored and for the white babies.

*Relation of Size of Infant Skull to Birth Weight:* It seems to be a fairly general belief that the size of the fetal skull as determined by cephalopelvimetric study can be used as an indicator of the over-all fetal size. The present investigation gave an opportunity for determining the accuracy of this belief. The skull volume, computed as previously described, was

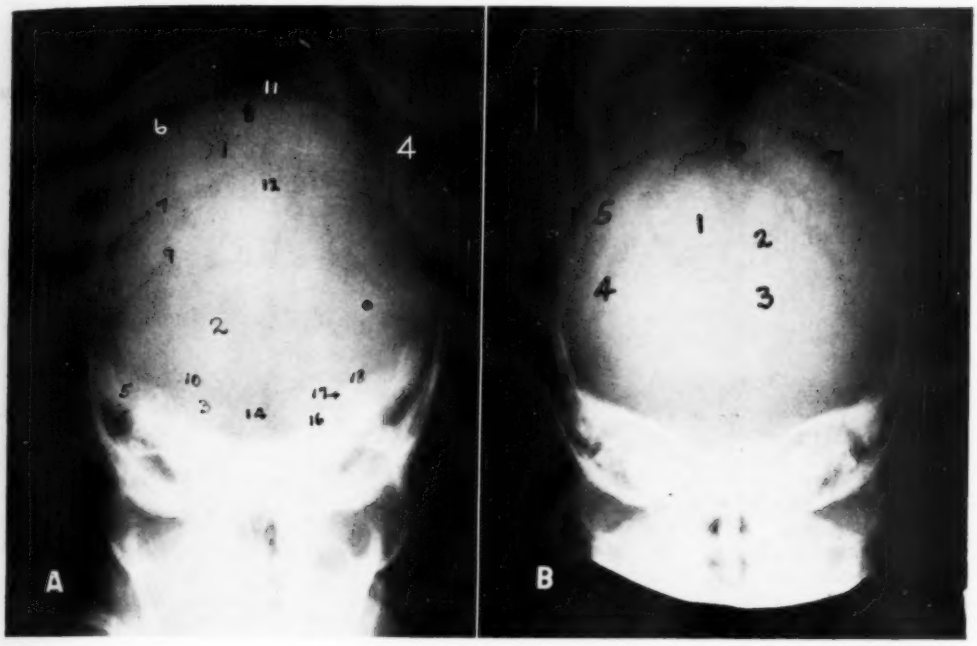


Fig. 3. Occipital view of skull of newborn.

A. 1. Occipital, squamous (intramembranous) portion. 2. Occipital, squamous (cartilaginous) portion. 3. Occipital, right lateral portion. 4. Parietal. 5. Temporal, petrous portion. 6. Lambdoid suture. 7. Coronal suture. 8. Remnant of fissure between two halves of interparietal portion of occipital. 9. Remnant of fissure between interparietal and supra-occipital portions of occipital bone. 10. Fissure between squamous and lateral portions of occipital. 11. Posterior fontanelle. 12. Anterior fontanelle. 13. Posterolateral fontanelle. 14. Foramen magnum. 15. Mastoid antrum. 16. Porus acusticus internus. 17. Superior semicircular canal. 18. Arcuate eminence.

B. 1. Anomalous intramembranous occipital center of ossification. 2. Fissure between main intramembranous portion of squama occipitalis and anomalous occipital center of ossification. 3. Main intramembranous portion of squama occipitalis. 4. Future lambdoid suture. 5. Parietal. 6. Posterior fontanelle (shadow superimposed upon that of anterior fontanelle). 7. Future coronal suture.

compared with the birth weight. No direct relation could be found. For example, the smallest infant in the series, four weeks premature, weighing 5 pounds 1 ounce at birth, had a skull volume of 1,366 c.c., while a large full-term infant, weigh-

TABLE V: MEASUREMENTS OF INFANT SKULL

| | Range | Average |
|---|---|---|
| SELLA TURCICA (100 infants) | | |
| Anteroposterior diameter | 4.0–6.5 mm. | 5.2 mm. |
| Depth | 1.5–3.5 mm. | 2.5 mm. |
| SKULL DIAMETERS | | |
| Entire group (100 infants) | | |
| Anteroposterior | 10.6–13.8 cm. | 12.5 cm. |
| Vertical height | 9.0–13.1 cm. | 10.18 cm. |
| Breadth | 9.0–11.2 cm. | 10.2 cm. |
| Colored (61 infants) | | |
| Anteroposterior | 10.6–13.8 cm. | 12.51 cm. |
| Vertical height | 9.0–13.1 cm. | 10.12 cm. |
| Breadth | 9.0–11.2 cm. | 10.1 cm. |
| White (39 infants) | | |
| Anteroposterior | 11.7–13.5 cm. | 12.48 cm. |
| Vertical height | 9.1–11.2 cm. | 10.25 cm. |
| Breadth | 9.2–11.0 cm. | 10.3 cm. |
| SKULL VOLUME (L × B × H; not actual volume) | | |
| Entire series (100 infants) | 917–1563 c.c. | 1275 c.c. |
| Colored (61 infants) | 917–1531 c.c. | 1277 c.c. |
| White (39 infants) | 1105–1563 c.c. | 1273 c.c. |
| SEPARATION OF CRANIAL BONES | | |
| Future lambdoid suture | | |
| Lateral view | 1.5–10.0 mm. | |
| Occipital view | 3.0–11.0 mm. | |
| Future coronal suture | | |
| Lateral view | 1.5 to 11.0 mm. | |
| Future sagittal suture | | |
| Occipital view | 3.0 to 17 mm. | |
| BASE ANGLE | | |
| Angle between squamous portion of occipital below superior nuchal line and base of skull anterior to occipital squama | 100–125° | 112° |

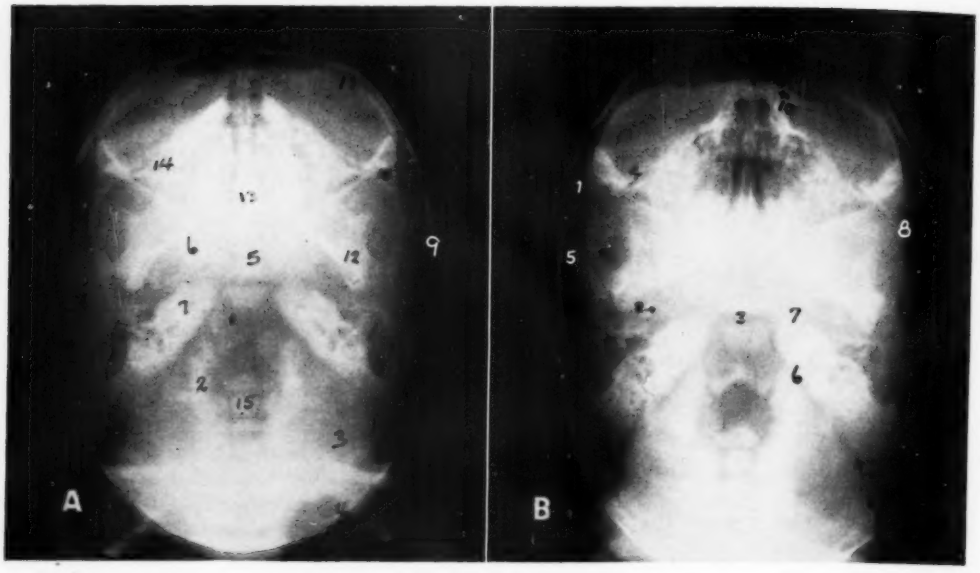


Fig. 4. Base view of skull of newborn.

A. 1. Occiput, basilar portion. 2. Occiput, right lateral portion. 3. Occiput, squamous (cartilaginous) portion. 4. Occiput, squamous (intramembranous) portion. 5. Sphenoid, body. 6. Sphenoid, greater wing. 7. Temporal, petrous portion. 8. Temporal, squamous portion. 9. Parietal. 10. Zygoma. 11. Frontal. 12. Mandible. 13. Vomer. 14. Maxilla. 15. Cervical spine.
B. 1. Coronal suture. 2. Temporo-sphenoidal suture. 3. Occipito-sphenoidal suture. 4. Zygomatico-maxillary suture. 5. Temporo-parietal suture. 6. Petro-occipital fissure. 7. Spheno-petrosal fissure. 8. Anterolateral fontanelle. 9. Posterolateral fontanelle. 10. Nasomaxillary suture.

ing 8 pounds 14 ounces, had a skull volume of 1,350 c.c.

*Separation of Cranial Bones:* The cranial bones are separated to a surprising extent in some newborn babies, while in others separation is only slight. Moloy's (5) work would indicate that the degree of separation is greater several days after birth than immediately postnatal. In all cases, however, there is a real separation, the sutures as such not being formed until later in life. That is, the spaces in the newborn are filled in by membrane. The greatest amount of separation is seen between the parietals, being found in one case to measure 17 mm.

*The Base Angle:* The squamous portion of the occipital below the superior nuchal line forms a pronounced angle with the base of the skull anterior to the occipital squama. This can be seen and measured on the lateral view. It appears more acute in the newborn than in the adult, probably due to elevation of the squama occipitalis incidental to molding. The angle in this group of infants was found to vary between 100 and 125°.

*Linear Index:* Schüller (7) uses a "linear index" as a means of expressing the shape of the head. Obviously this was meant to apply to the older individual, but it also serves to indicate the shape of the newborn skull. If the breadth of the skull, multiplied by 100, be divided by the occipito-frontal diameter, a figure, the linear index, is obtained, which varies according to whether the skull is short, long, or of average anteroposterior diameter. Schüller states that an index between 70 and 80 is

TABLE VI: LINEAR INDEX AND SHAPE OF THE SKULL

| Type of Skull | Linear Index | Number | |
|---|---|---|---|
| | | Colored | White |
| Brachycephalic | Above 80 | 36 | 17 |
| Mesocephalic | 70 to 80 | 25 | 21 |
| Dolichocephalic | Below 70 | ... | 1 |

found in the mesocephalic skull, above 80 in the brachycephalic, and below 70 in the dolichocephalic.

It is interesting to note that the only infant in this series with a dolichocephalic head (see Table VI) was born by cesarean section, with no preceding maternal labor. The large number of brachycephalic skulls in this group of cases—53—is probably misleading. Obviously the forces of labor would tend to change the configuration of the skull at birth, and the abnormal shape seen after a long molding process tends to disappear after the first few days of postnatal life. On the other hand, the highest linear indices were not seen in those cases in which maternal labor was longest. When, however, one considers the large number of colored babies in this group, it seems more than ever evident that molding must account for much of the brachycephaly seen here. von Török (8) designated the Negroes, among others, as a manifestly dolichocephalic race. Schüller (7) says that we do not know why certain races are dolichocephalic and others brachycephalic, but that the fact has been mentioned that every race, with the progress of culture, has the tendency to become brachycephalic.

*Miscellaneous Findings:* In Table VII there are grouped miscellaneous observations noted on examination of the infant skull roentgenograms in this series. Several of these findings are deserving of brief comment.

A persistent anomalous bone (the posterior interparietal or Inca bone) in the adult is not a common finding, but in 18 of these infants there were definite posterior fontanelle or anomalous occipital centers of ossification. Some were quite large. One in particular was striking in appearance, the impression given being that of a bone fragment broken sharply off the adjacent occipital.

Pancoast, Pendergrass, and Schaeffer (6) state that: "In infants the bones of the skull present roentgenographically a relatively homogeneous appearance, which is in sharp contrast to the irregular areas of rarefaction and increased density seen in the adult skull. . . . The bones of the infant skull do not contain so much inorganic material as adult bones, and, also, lack a diploic structure. Furthermore, the vari-


Fig. 4, C. Base view of skull of newborn.

1. Carotid canal. 2. Internal carotid foramen. 3. External carotid foramen. 4. Tympanic ring and external auditory meatus. 5. Ossicles. 6. Cochlea. 7. Fenestra vestibuli. 8. Facial canal. 9. Stylomastoid foramen. 10. Mastoid antrum. 11. Porus acusticus internus. 12. Foramen ovale.

TABLE VII: MISCELLANEOUS FINDINGS ON EXAMINATION OF THE NEWBORN SKULL

| | Incidence (100 Infants) |
|---|---|
| Posterior fontanelle bones | 15 |
| Anterolateral fontanelle bones | 10 |
| Sutural bones | 51 |
| Separate occipital centers of ossification | 3 |
| Vascular markings in frontal | 44 |
| Convolutional (?) markings in parietal | 26 |
| Markings due to folds of scalp | 33 |
| Radiating striate markings of parietal (Due to manner in which bone is laid down?) | 3 |
| Cleft in posterior half of parietals (Residual embryonal cleft) | 1 |
| Parieto-occipital flattening (Due to molding in labor, or to resting on hard bony surface of maternal pelvis?) | 23 |
| Upward displacement of squama occipitalis | 5 |
| Upward bulge of parietal bones | 10 |
| Apparent ethmoidal cells | 12 |
| Deviation of nasal septum from mid-line | 11 |

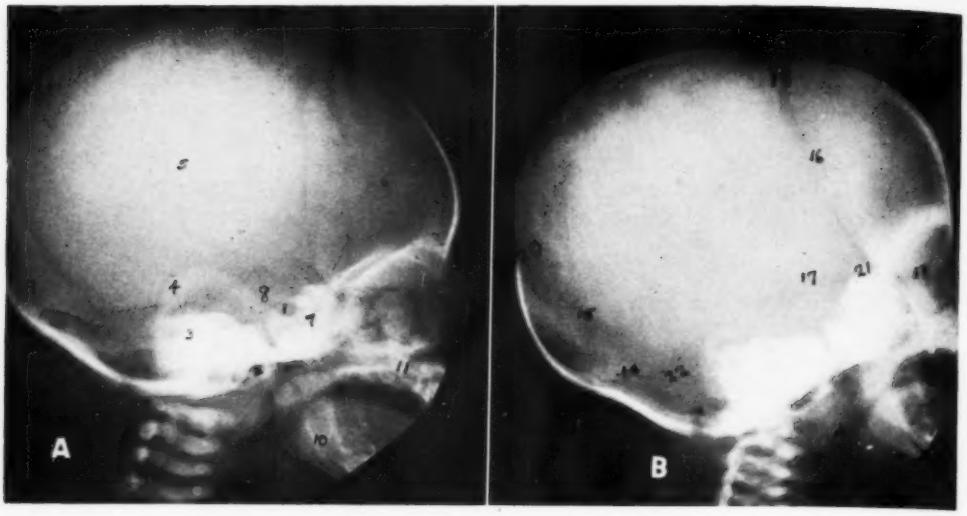


Fig. 5. Lateral view of skull of newborn.

A. 1. Sella turcica. 2. Tympanic ring. 3. Mastoid antrum. 4. Pinna of ear. 5. Parietal. 6. Frontal. 7. Sphenoid. 8. Temporal, squamous portion. 9. Occipital. 10. Mandible with teeth. 11. Maxilla with teeth. 12. Nasal bone.

B. 13. Junction of squamous and lateral portions of occipital. 14. Remnant of fissure between basal and interparietal portions of occipital squama. 15. Lambdoid suture. 16. Coronal suture. 17. Squamosal suture. 18. Fronto-ethmoidal suture. 19. Anterior fontanelle. 20. Posterior fontanelle. 21. Anterolateral fontanelle. 22. Posterolateral fontanelle.

ous vessel grooves and ridges, commonly seen in the adult, are not sufficiently well marked during infancy to show in the roentgenogram."

While vascular markings could not be distinguished in the parietal bones in any of the babies studied in this investigation, yet in 44 of the group there were distinct vascular shadows in the frontal bones. The presence of convolutional impressions is a debatable point. Areas of lessened density which we believe represent convolutional markings were seen in the parietal bones in 26 infants. It is conceded, however, that these shadows may be due to variations in bone thickness intrinsic in the way in which bone is laid down in membrane.

Some degree of parieto-occipital flattening was seen in 23 babies. As stated previously, Mueller (7) believes that variation in skull shape may be brought about through long continued resting of the fetal head upon the pelvic inlet in cases in which the amniotic fluid is scanty. He admits, however, the effect of the forces of labor in further shaping the skull. Upward displacement of the basal portion of the squama occipitalis, seen in 5 cases, might be due to a combination of these factors. On the other hand, an appearance as of upward bulging in the parietal area, noted in 10 infants, is probably due entirely to fetal head molding during labor.

Development of the nasal accessory sinuses in the infant and young child is discussed by Camp (2), Tremble (9), and Wasson (11). Tremble (9) also describes the process of pneumatization of the temporal bone. The ethmoid and maxillary sinuses and the sphenoid sinuses in the presphenoid area are partially developed at birth, but the time at which they first become aerated is uncertain. Tremble (10) says that the mastoid antrum is practically always present at birth, even in cases in which the external meatus and auricle are undeveloped. He quotes Cheatle to the effect that this is not the only cell to be seen at the time of birth.

The lateral wall of the antrum is studded with minute cells which enlarge as the mastoid process grows.

Although roentgen examinations in the maxillary sinus position were made in all of these infants, detailed study failed to show any conclusive evidence of maxillary sinuses on the films. On the other hand, in 12 infants small radiolucent shadows were seen medial to the orbital shadows which were believed to be due to small aerated ethmoid cells. No evidence of frontal or sphenoid sinuses could be seen. In all of the infants in whom the mastoids were examined, a well developed mastoid antrum was found. An interesting finding in connection with the upper air passages was some deviation of the nasal septum from the mid-line in 11 cases.

A detailed survey of the roentgenograms made in the various positions previously described and concomitant study of the skull of a newborn infant permitted identification of many structures which had been hitherto more or less unrelated parts of a puzzle. In the hope that mapping of these various parts may be of interest and of some assistance in infant skull interpretation, several roentgenograms are presented, the various recognizable areas being indicated by numbers with accompanying legends.


## SUMMARY

Roentgen examinations of the skull were made in a group of 100 healthy newborn infants. Postero-anterior, lateral, occipital, mento-vertical, and maxillary sinus positions were used in all cases, and a sufficient number of studies of the lateral mastoid region was made to obtain familiarity with the appearance of this part of the skull. The technical factors used in the examinations have been listed.

The embryological development of the skull is reviewed briefly.

Measurements of the sella turcica, of the various skull diameters, of the degree of separation of the cranial bones, and of the angle between the squamous portion of the occipital below the superior nuchal line and the base of the skull anterior to the occipital squama were made.

Average diameters in millimeters for the sella turcica were: anteroposterior, 5.2; depth, 2.5. Average skull diameters in centimeters were: anteroposterior, 12.5; vertical height, 10.18; breadth, 10.2.

Determination of the linear index as described by Schüller revealed a preponderance of brachycephalic skulls in this group, presumably due in part to molding of the head during labor.

No direct relation could be found be-


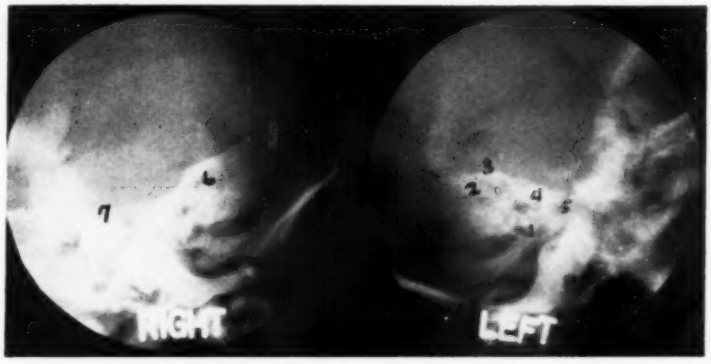


Fig. 6. Lateral mastoid view of skull of newborn.

1. Tympanic ring. 2. Mastoid antrum. 3. Tegmen tympani. 4. Porus acusticus internus. 5. Internal carotid foramen. 6. Superior semicircular canal. 7. Sella turcica.

tween the size of the newborn skull and the body birth weight.

Separation of the cranial bones was found to vary greatly. In the case of the future sagittal suture, the film measurement of the greatest distance between the parietal bones at the vertex varied from 3 to 17 mm. The width of the future lambdoid suture in one infant was only 1.5 mm., while the greatest separation measured 11 mm. Similar extreme measurements were noted in the future coronal suture.

The cartilaginous portion of the squama of the occipital bone forms a more acute angle with the base of the skull anteriorly than in the case of the adult, averaging 112° in the newborn.

Various miscellaneous findings, including the incidence of posterior fontanelle bones and of anomalous occipital centers of ossification, the presence of vascular markings and of apparent convolutional impressions, mastoid development, nasal accessory sinuses, congenital deflection of the nasal septum, and deformities of the skull due to prenatal causes and to molding in labor are discussed.

Finally, the various structures in the infant skull which can be identified have been indicated on roentgenograms.

NOTE: The authors wish to express their appreciation to Mr. Thomas Garrett, former x-ray technician at the E. S. Magee Hospital, now serving in the United States Navy, and to Misses Clara B. Wedge and Martha J. Ulrich, x-ray technicians, E. S. Magee Hospital, for their valuable help in examining this group of infants.

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# Mid-Line Anomalies of the Brain: Their Diagnosis by Pneumoencephalography[1]

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IN THE MID-LINE of the brain are situated two anatomical structures that may be involved by rare developmental anomalies. They are the septum pellucidum and the corpus callosum.

From August 1942 to August 1944, pneumoencephalograms or ventriculograms were made on 96 patients of the Indiana University Medical Center. In 6 cases congenital cysts of the septum pellucidum were demonstrated and in 2 cases agenesis of the corpus callosum was found. A review of the available literature has revealed 15 cases of the former anomaly and 18 of the latter that were diagnosed by encephalography.

Rarity as a quality of any abnormal condition has and always will incite the interest of the physician. It is such a stimulus that has prompted our presentation of this paper. The anomalies described will be presented separately for clarity.

## CYSTS OF THE SEPTUM PELLUCIDUM

Practically all anatomy books describe the cavum septi pellucidi and cavum vergae. The former is better known as the fifth ventricle and the cavum vergae has been called the sixth ventricle. The cavum septi pellucidi has been known at least since the time of Sylvius. The cavum vergae is named for Andrea Verga, who described it in 1851. However, according to Dandy (1), Ferrario was the first to publish his observations of this structure. These cavities are obviously not a portion of the ventricular system. They have a different embryonic derivation, are not lined by ependyma, and only under abnormal conditions do they communicate with the ventricles.

The septum pellucidum is a thin, somewhat triangular, two-leaved membrane, which separates in a vertical plane portions of the two lateral ventricles. It is found within the confines of the corpus callosum. The two cavities which we are now discussing are not independent. When both are present, they usually communicate and, from the developmental standpoint, the cavum vergae is simply the posterior portion of the cavum septi pellucidi.

The cavum septi pellucidi has the following boundaries: anteriorly, the genu of the corpus callosum; superiorly, the body of the corpus callosum; posteriorly, the anterior limb and the pillars of the fornix; inferiorly, the rostrum of the corpus callosum and the anterior commissure; laterally, the leaves of the septum pellucidum.

The cavum vergae is bounded as follows: anteriorly, by the anterior limb of the fornix; superiorly, by the body of the corpus callosum; posteriorly, by the splenium of the corpus callosum; inferiorly, by the psalterium and hippocampal commissure, the fibers of which bridge the space between the diverging posterior pillars of the fornix; laterally, by the leaves of the septum pellucidum.

There are two theories as to the origin of these cavities. One, supported by Thompson (2), holds that the rapid widening of the lamina terminalis during the third month of fetal development causes an internal tension with the resultant formation of a cavity within its substance.

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According to the other theory, the cavity is a part of the interhemispheric fissure whose lateral boundaries are the medial aspects of the cerebral vesicles ventral to the caudally extending corpus callosum. Corning (3) supports this theory. He believes that the cavity reaches back to the splenium in the seventh fetal month and that from the eighth to the ninth fetal month the caudal end of the cavity is gradually obliterated by the union of the floor with the corpus callosum. He contends that this explains the much higher frequency of a patent cavum septi pellucidi without a cavum vergae.

Wolf and Bamford (4) also favor the latter theory. They call attention to the constancy with which the structure of the cavum septi pellucidi is produced and find it difficult to imagine a varying tension within the lamina terminalis producing such a uniform result.

There has been much debate as to whether the communications that sometimes exist between these cavities and the lateral or third ventricles are normal or artificial. Dandy, among others, believed them to be artificial because their borders are ragged and shreds of tissue can be seen hanging from the sides of the orifices, and they are inconstant in position, size, and number. It would appear that, if these openings were normal, they would exist in all cysts of the cavum septi pellucidi or cavum vergae.

There has been no satisfactory explanation given for the source of the fluid that forms in these cavities.

Dandy, and Van Wagenen and Aird (5) have described three types of dilatation of the cavum septi pellucidi and the cavum vergae:

1. Non-communicating type, in which the walls of the cavity are intact.
2. Communicating type, in which an opening or openings exist between the cavity and the lateral or third ventricles, caused by rupture when the intracystic tension becomes too great.
3. Acquired or secondary type, as a part of a later developing internal hydrocephalus.

The non-communicating types are of clinical significance because they may obstruct the interventricular foramina, with resultant increased intracranial pressure and associated signs and symptoms. Their diagnosis, however, depends upon encephalography or ventriculography.

Meyer (6), in 1930, was the first to report the diagnosis of a non-communicating cyst of the septum pellucidum by encephalography. Dandy, in 1931, first described a case diagnosed by ventriculography. Dyke (7) stated that this type of anomaly is extremely rare. He found only one well established case in 5,000 encephalograms.

The communicating type of cyst may not produce clinical symptoms. In most cases, however, convulsive seizures occur, and it should be noted that few patients have encephalographic studies without some evidence of intracranial disturbance.

Pendergrass and Hodes (8) were the first to give a detailed description of the encephalographic appearance of cysts of the cavum septi pellucidi and cavum vergae. The septum pellucidum can be seen only in the anteroposterior or postero-anterior projection of the skull, following the satisfactory filling of the lateral ventricles with a gas. It appears as a thin vertical density separating the lateral ventricles. Its normal width is 1.5–3.0 mm. The slightest widening of the septum pellucidum should lead one to suspect a cyst of this structure. Pendergrass and Hodes emphasize the importance of a careful search for slight changes in the density of the air shadow in the ventricles close to the septum, which might easily be overlooked.

In the non-communicating type there is usually a dilatation of the ventricular system, particularly one or both lateral ventricles, due to obstruction of one or both interventricular foramina and/or the aqueduct of Sylvius.

The lateral ventricles are separated by the mass of the cyst. The filling defect

Fig. 1. Case 1: Widening of the septum pellucidum measuring 5 mm. in the sagittal view. Density (arrows) superimposed on the bodies and anterior horns of the lateral ventricles in the lateral projection.

may be bilaterally symmetrical or more pronounced on one side than the other. The third ventricle may be depressed by the distended cyst. If calcified, the pineal gland may be seen to be displaced downward.

In the lateral view, the non-communicating cysts are seen as areas of increased density superimposed upon the bodies of the lateral ventricles. This shadow, if produced by a cyst of the cavum septi pellucidi, is comma-shaped, having its greatest diameter anteriorly and tapering to a blunt point posteriorly. If the cyst is of the cavum vergae, its shadow should be located more posteriorly than that of the cavum septi pellucidi and is oval or bean-shaped. When both cysts occur, they appear in the lateral view as a somewhat hourglass-shaped area of density, the waist of the shadow being the point of connection of the two cysts.

Cavum septi pellucidi of the communicating type appears in the sagittal projections as an air-containing space separating the lateral ventricles. The two leaves of the septum pellucidum are clearly seen as linear densities separating the air of the cavity from that in the ventricles. The roof of the cavity is about at the level of the lateral ventricles at their medial aspect. The floor of the cavity is usually on the same level as the floor of the bodies of the lateral ventricles.

In the lateral view, the cavum septi pellucidi might easily escape detection if it were not seen in the sagittal projections, because of its superimposition on the anterior horns and bodies of the lateral ventricles. It may easily be mistaken for a small amount of air in the opposite ventricle. It has a comma shape. The anterior border does not extend as far forward as the anterior horns of the lateral ventricles. Its tapering posterior limit approaches a point above the junction of the aqueduct of Sylvius and the third ventricle.

A cavum vergae of the communicating type appears the same as the cavum septi pellucidi in the sagittal projections, except that it may be somewhat smaller and it extends under the lateral ventricles with the curve of the fornix. In the lateral projection it is seen as a radiolucent area, oval in shape, extending for 1–2 cm. in its longest diameter back from the usual pos-

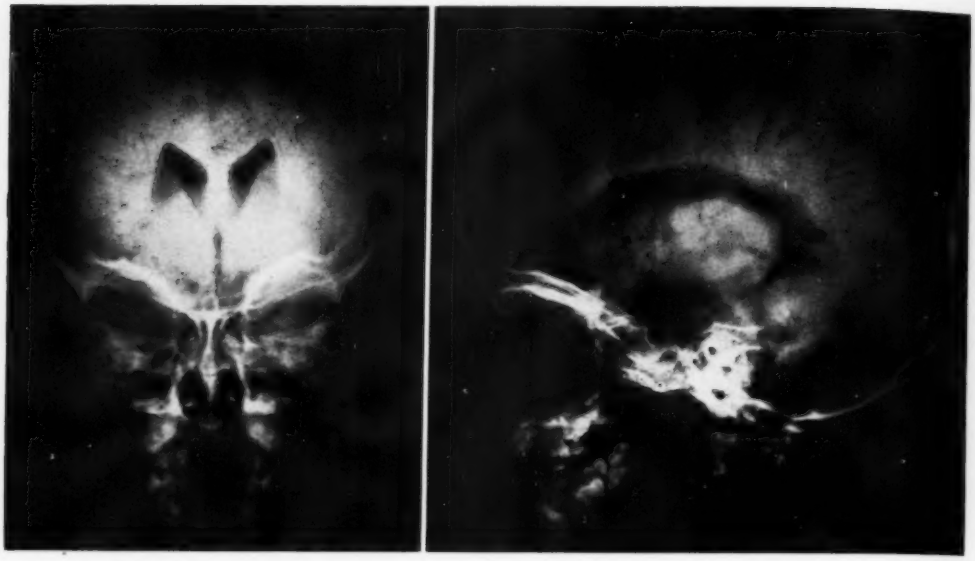

Fig. 2. Case 2: Widening (6 mm.) of the septum pellucidum in the sagittal projection. Density (arrows) superimposed on the anterior horns and anterior portions of the lateral ventricles in the lateral view.

terior limit of the cavum septi pellucidi. When both cavities are present, the radiolucent area is roughly hourglass in shape.

Congenital cysts of the septum pellucidum of the communicating type are easily diagnosed if satisfactory films are obtained and studied carefully. They may be mistaken for the third ventricle due to superimposition. Cysts of the noncommunicating type, however, may be simulated by a variety of lesions, some of which deserve mention. They are (1) solid tumors of the septum pellucidum, (2) lesions of the corpus callosum, (3) tumors of the lateral ventricles arising from the medial wall, (4) mid-line lesions in the frontal region, (5) third ventricle lesions, (6) pinealomas, and (7) meningiomas of the olfactory groove.

## *Case Reports*

CASE 1: B. F., a four-and-a-half-year-old white girl, was admitted to the hospital on Aug. 28, 1942, because of convulsions, loss of weight, and a peculiar gait. The first convulsion occurred in June 1941 and was reported to have lasted for over an hour. According to the description, the attack was a typical grand mal seizure. There had been seven such attacks since the initial one.

Physical examination was essentially negative except for the fact that the child walked with a slight inversion of the right foot and some footdrop was also noted on that side. Blood, urine, and spinal fluid examinations were negative. Encephalograms made on Sept. 14, 1942, were reported as normal. The patient was discharged to the Cerebral Palsy Clinic as an epileptic and cerebral spastic.

Psychometric tests on May 24, 1944, showed an average range of intelligence with a mental age between five and eight years and an I.Q. of 90. The patient continues to require maintenance doses of sedative drugs for convulsive seizures.

*Comment:* This case was not recognized until the films were surveyed in preparation of this paper. A widening of the septum pellucidum, which measures 5 mm., is readily seen. We believe that the density identified by the arrows anteriorly in the lateral view localizes this as a cyst of the cavum septi pellucidi (Fig. 1).

CASE 2: J. J. J., a four-year-old white male, was admitted to the hospital on Jan. 20, 1943. He had always had difficulty in walking. He had been seen in the Orthopedic Clinic in 1940, at which time he was referred to the Spastic Clinic for instructions and exercises. He was also seen in the Neurological Clinic, and hydrocephalus was suspected.

Physical examination showed the circumference of the head to be 57 cm. The patellar and ankle jerks were hyperactive. The patient walked unsteadily on the toes, with both feet in equinus posi-

Fig. 3. Case 3: Dense filling defects with convex lateral borders in the bodies of the lateral ventricles, apparently arising from their medial walls seen in the sagittal projection. Comma-shaped density (arrows) superimposed upon the bodies and posterior portions of the anterior horns of the lateral ventricles and lack of filling of the aqueduct and fourth ventricle in the lateral view.

tion. All laboratory tests were negative. Encephalograms made on Jan. 25, 1943, were reported as normal.

The patient was discharged on Jan. 28, 1943, to be followed in the outpatient clinic. The diagnosis on discharge was cerebral spastic paralysis.

*Comment:* This case was also missed until a review of the films in preparation for this paper revealed widening of the septum pellucidum, evidence of a non-communicating cyst of the cavum septi pellucidi (Fig. 2).

CASE 3: A. L., a 29-year-old white male, was admitted to the hospital on May 1, 1943, complaining of severe headaches and poor vision. For the past three months he had had numerous attacks of vomiting, severe headache, usually frontal, dizziness, failing vision, fainting spells, and an occasional convulsion.

On admission, the physical examination showed swelling of the optic nerve heads of 5 diopters. Ventriculography on May 13, 1943, revealed a dense filling defect in the medial walls of both lateral ventricles, with widening of the shadow of the septum pellucidum (Fig. 3). There was also a rounded filling defect in the floor of the third ventricle. The third and lateral ventricles were dilated. The fourth ventricle was not visualized. The diagnosis was tumor of the midbrain with obstruction of the aqueduct of Sylvius and internal hydrocephalus. Repeat ventriculograms made on June 14, with the patient erect, revealed a large communicating cyst of the cavum septi pellucidi and cavum vergae (Figs. 4 and 5).

The patient's condition failed to improve; he became comatose and died on June 23, 1943.

*Autopsy:* Examination of the brain after fixation in formaldehyde showed the superior portion of the midbrain replaced by a fairly sharply outlined, somewhat spongy, disk-shaped mass measuring approximately 25 mm. in the vertical diameter and 10 mm. in the horizontal. The mass pushed superiorly and posteriorly to compress the aqueduct, thus leading to dilatation of the lateral and third ventricles. In addition, there was a large cyst-like structure lying in the mid-line, above the third ventricle. This cavity represented a posterior extension of the cavum septi pellucidi and extended to the posterior commissure of the corpus callosum or splenium. It measured 65 mm. in length, 12 mm. in the vertical diameter at the posterior limit, and 25 mm. in the anterior portion. The lateral walls were stretched and thin. There was a defect, presumably due to puncture by the ventricular trocar, in each lateral wall (Fig. 6).

*Comment:* The non-communicating cyst of the cavum septi pellucidi and cavum vergae were overlooked in the first ventriculograms until the second examination, at which time the walls were apparently ruptured by the trocar. In the sagittal view of the second examination (Fig. 4)

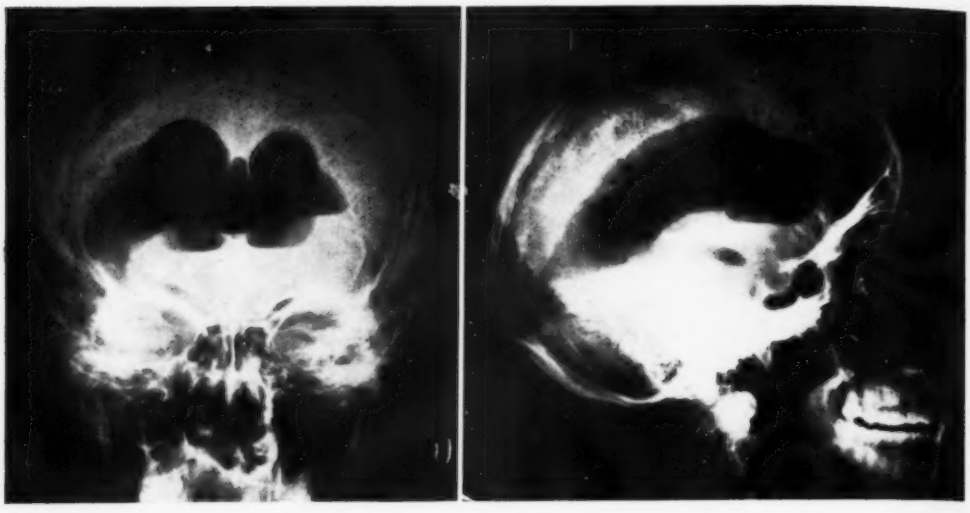

Fig. 4. Case 3: Air outlining the broad slit-like cavum septi pellucidi and triangular cavum vergae in sagittal view. Comma-shaped radiolucent area corresponding to position of septum pellucidum in lateral projection. Note fluid levels in both views.

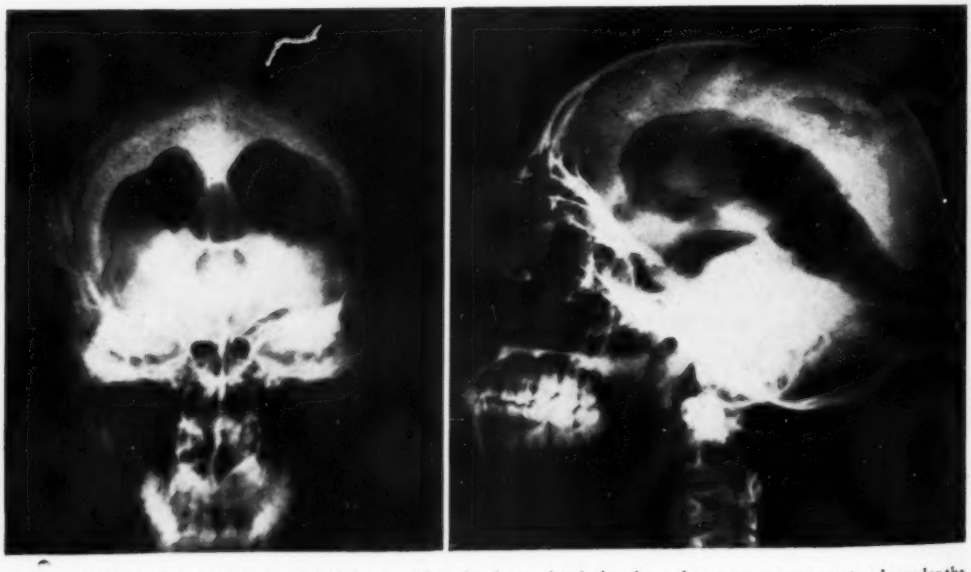

Fig. 5. Case 3: Same findings as in Fig. 4. Note in the sagittal view how the cavum vergae extends under the lateral ventricles with the curve of the fornix. Hydrocephalus of the lateral and third ventricles.

the cavum vergae is seen flaring out laterally beneath the lateral ventricles with the curve of the fornix. We believe that this finding is an aid in differentiating between a cyst of the cavum vergae and of the cavum septi pellucidi.

CASE 4: J. J.,[4] a two-year-old white female, was admitted to the hospital on Dec. 13, 1943, because of a hydrocephalus, noticed shortly after birth, and an abnormal weakness of the lower limbs. The physi-

[4] We wish to acknowledge the courtesy of Dr. Robert L. Glass, who has kindly permitted us to report this case.

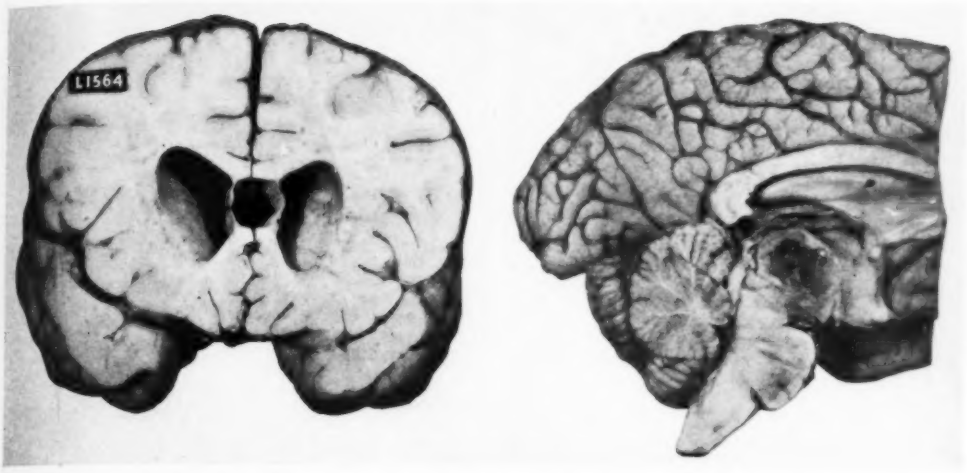


Fig. 6. Case 3: Autopsy specimen. Note wide separation of the leaves of the septum pellucidum in the coronal section. The medial view reveals the tumor in the midbrain compressing the aqueduct of Sylvius and the defect in the right leaf of the septum pellucidum, presumably produced by the ventricular trocar.

Fig. 7. Case 4: Communicating cyst of the cavum septi pellucidi clearly seen in both views. Hydrocephalus especially marked in posterior portions of the lateral ventricles.

cal examination was essentially negative. Blood, urine, and spinal fluid findings were normal. An encephalographic examination was attempted on Dec. 14, but the ventricles were not demonstrated. Ventriculograms made on Dec. 20 revealed a communicating cyst of the cavum septi pellucidi and internal hydrocephalus (Fig. 7). The patient was discharged improved on Dec. 24. Dr. Glass reports that she has been observed in his office since and has continued to show signs of improvement.

*Comment:* This may represent another case of a non-communicating cyst made communicating by the introduction of a ventricular trocar through its wall.

CASE 5: J. J. M., a white male infant of two months, was admitted on April 22, 1944, having had several convulsions daily for three days prior to admission. He had been a premature baby, weighing

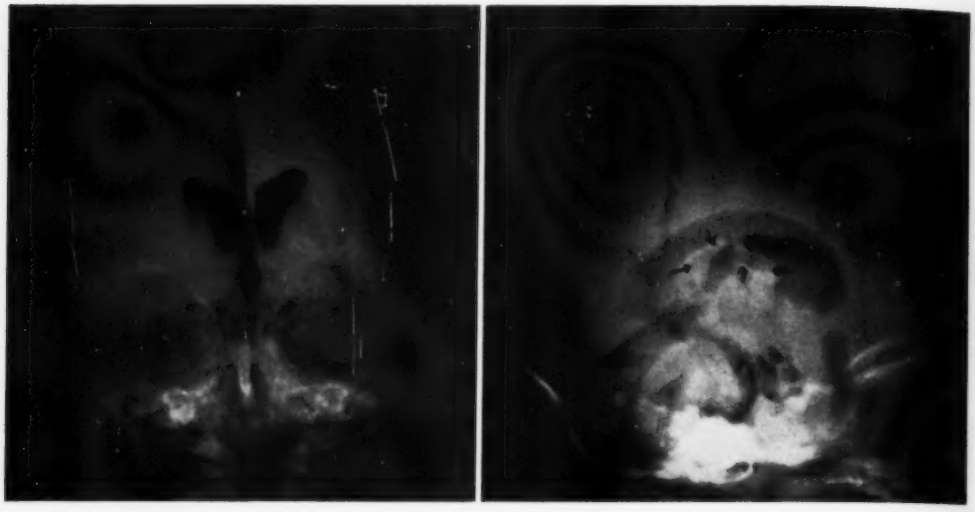

Fig. 8. Case 5: Communicating cyst of the cavum vergae (arrows) and non-communicating cyst of the cavum septi pellucidi (widened septum in the sagittal view).

4 pounds 13 ounces at birth. On admission he weighed 8 pounds. The physical examination was essentially negative. A Mazzini test of the mother's blood was negative. Blood, urine, and spinal fluid findings were normal. Encephalograms made on April 28 revealed a communicating cyst of the cavum vergae, and a non-communicating cyst of the cavum septi pellucidi (Fig. 8).

The convulsions decreased in frequency, and the child was discharged on May 6, 1944, with a maintenance dose of 1/2 gr. phenobarbital t.i.d. When seen on July 25, 1944, in the outpatient clinic, he had had no convulsions, was eating well and gaining weight, and objectively there were no abnormalities.

*Comment:* There was no definite explanation for the admission complaints in this case. Convulsive seizures are not uncommon, however, in the presence of these anomalies. These complaints have been reported as improving or disappearing following encephalography.

CASE 6: D. J. A., a white female infant aged eight months, was admitted to the hospital on July 21, 1944, because of convulsions, emotional instability, and bowel and urinary incontinence of three weeks' duration.

Physical examination was essentially negative. Laboratory studies were non-informing. Encephalograms made on Aug. 17, 1944, revealed a moderate dilatation of the ventricular system. A communicating cyst of the cavum vergae was demonstrated. There was some coarsening of the subarachnoid pathways, suggesting the possibility of cerebral hypoplasia (Fig. 9).

The patient continued to have convulsions and was placed on a maintenance dose of phenobarbital, with a reduction in the number of seizures. She was discharged on Aug. 18, 1944, to be followed in the outpatient clinic.

### AGENESIS OF THE CORPUS CALLOSUM

As stated at the beginning of this paper, the other mid-line anomaly which we wish to discuss is agenesis of the corpus callosum.

Prior to the introduction of encephalography by Dandy in 1919, the diagnosis of agenesis of the corpus callosum was dependent upon its accidental discovery at autopsy, since a definite clinical syndrome has never been established. It was not until 1934, however, that this anomaly was recognized in a living patient by encephalography and was reported by Davidoff and Dyke (9). The first of three cases reported by these authors was interpreted as revealing a communicating cyst of the cavum septi pellucidi. It was only at autopsy, following a craniotomy, that complete agenesis of the corpus callosum was recognized. Guttmann (10) failed to recognize the characteristic changes in the encephalograms in one case which was later discovered at autopsy. Had he done so, his would have been the first case diag-

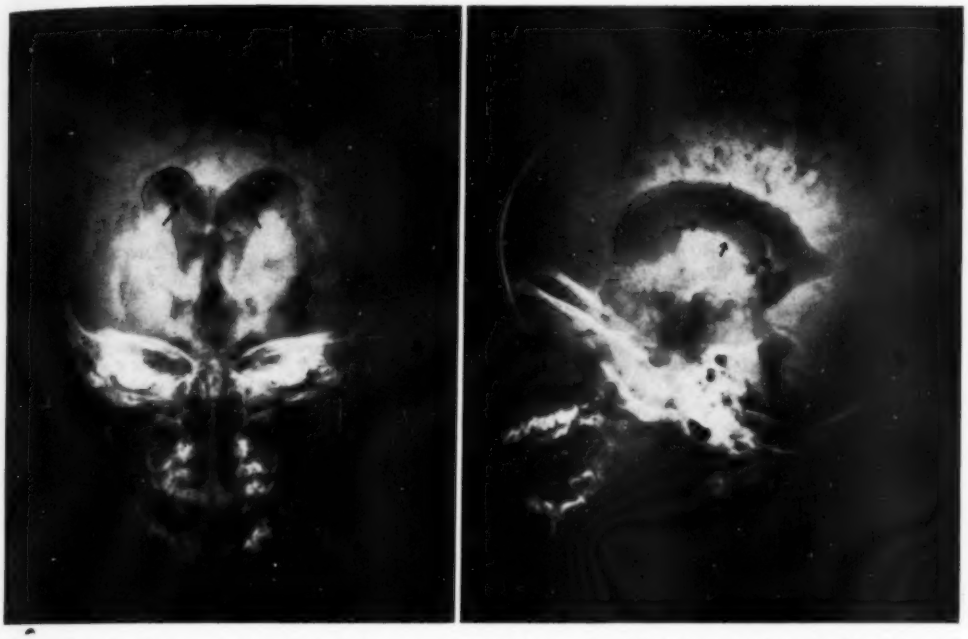

Fig. 9. Case 6: Communicating cyst of the cavum vergae (arrows). Dilatation of subarachnoid pathways. Note extension of the cavum vergae beneath the lateral ventricles (arrows) in the sagittal view.

nosed during life. Hyndman and Penfield (11) reported 5 cases. The first of these was discovered at operation after a diagnosis of cyst of the cavum septi pellucidi had been made.

The corpus callosum develops between the third and fifth month of fetal life. Retzius (12) has shown it to be an outgrowth of the lamina terminalis. Any arrested development of the corpus callosum is usually associated with faulty development of contiguous structures. Apparently the extent of the abnormality depends upon the time of embryonic arrest. Abnormalities may vary from a small defect in the splenium to complete absence of the corpus callosum, septum pellucidum, lyra of the fornices, and anterior commissure.

Bruce (13) has named the following subdivisions that may be used to determine the stage in the embryonic process at which arrested development has occurred:

*First three weeks:* Complete absence of the corpus callosum, when hemispheres and ventricular system are a single undivided unit.

*Fourth through the twelfth week:* Absence of the corpus callosum and anterior commissure, but perfect division of the cerebral hemispheres by the longitudinal fissure.

*During the fourth month:* Presence of the anterior commissure and genu of the corpus callosum.

Lesser degrees of agenesis of the corpus callosum vary directly in proportion to the lateness of onset of arrested development.

Before the formation of the corpus callosum, radially arranged, shallow sulci are often visible on the mesial aspects of the embryonic cerebral hemispheres. Retzius and other workers believe these sulci to be transitory structures. Davidoff and Dyke suggested that the radially arranged convolutions and sulci on the medial aspects of the brain in cases of agenesis of the corpus callosum represent an anomalous preservation of those structures occurring prior to the third month of fetal life, before the corpus callosum is formed. They

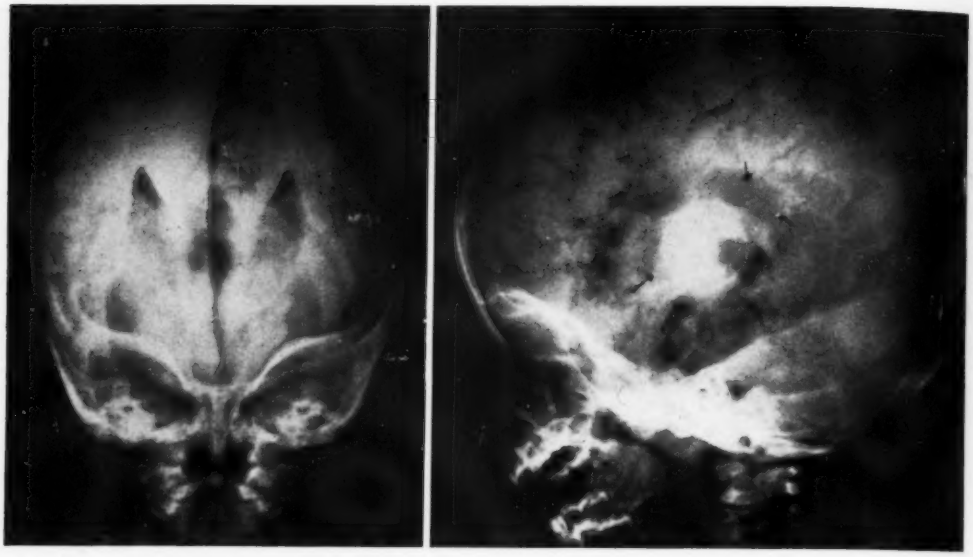

Fig. 10. Case 1: Complete agenesis of the corpus callosum. Separation of the lateral ventricles, pointing of their dorsal margins, concavity of their medial borders, and marked dilatation and elevation of the third ventricle in the sagittal view. A dilated interventricular foramen (single arrow) and radially arranged sulci (double arrows) extending through the zone of the corpus callosum, are seen in the lateral view.

base their opinion upon the fact that the preservation of these sulci in cases of complete agenesis can be demonstrated in the living, while in partial agenesis these radiations are found to be absent only dorsal to the partially formed corpus callosum and are seen to be retained where the latter structure has failed to develop.

Davidoff and Dyke concisely enumerate the characteristic encephalographic changes that are evidence of agenesis of the corpus callosum. They are: (1) marked separation of the lateral ventricles; (2) the angular dorsal margins of the lateral ventricles; (3) the concave mesial borders of the lateral ventricles; (4) the dilatation of the caudal portions of the lateral ventricles; (5) elongation of the interventricular foramina; (6) dorsal extension and dilatation of the third ventricle; (7) radial arrangement of the mesial cerebral sulci around the roof of the third ventricle and extension of these sulci through the zone usually occupied by the corpus callosum.

Bunts and Chaffee (14) state that no other cerebral lesion may be confused with this anomaly except possibly a communicating cyst of the cavum septi pellucidi.

Various other congenital defects such as porencephaly, microcephaly, and fetal configuration of the cortex of the brain and defects not related to the central nervous system may also exist in association with agenesis of the corpus callosum. Complete absence of this structure has been found in about one-half the cases reported.

Feeblemindedness and convulsive seizures are the most common symptoms in agenesis of the corpus callosum. Less common are spastic paraplegia, athetoid movements, strabismus, and nystagmoid movements of the eyes. None of these is pathognomonic of the anomaly.

### *Case Reports*

CASE 1: J. H. R., a seven-month-old white male infant, was admitted to the hospital on June 13, 1942, because of constipation, failure to gain weight, and feeding problem. All symptoms had been present since birth. Delivery had been normal. The patient could not sit at the time of admission. The family history was negative.

The child was markedly undernourished, pale, and somewhat dehydrated. The other positive physical

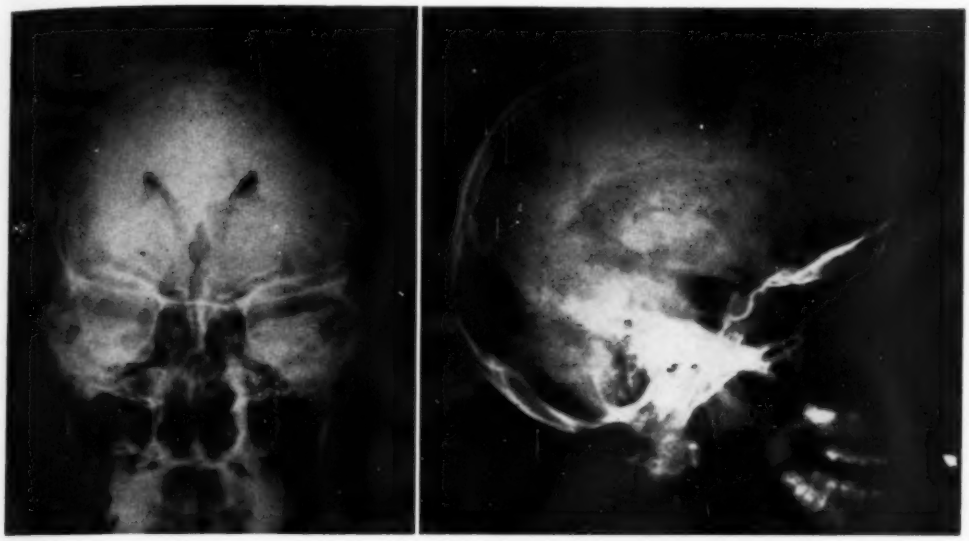

Fig. 11. Case 2: Partial agenesis of the corpus callosum. Separation of lateral ventricles, pointing of their dorsal margins, and elevation of the third ventricle all noted in the sagittal view. Findings inconclusive in lateral view.

findings were cervical lymphadenopathy and moderate abdominal distention. All laboratory examinations of the blood cells, serology, urine, and spinal fluid were normal.

X-ray examination of the cervical spine showed spina bifida occulta of each segment. With the aid of a barium enema a moderate megacolon was demonstrable. Encephalograms made on Aug. 5, 1942, revealed a dilatation of the lateral and third ventricles and the interventricular foramina. The lateral ventricles were separated, their dorsal margins were angular, and their medial walls were slightly concave. The third ventricle was markedly displaced dorsally between the lateral ventricles. The callosal sulcus was not visualized, and there was evidence of radially arranged mesial cerebral sulci around the roof of the third ventricle and extending through the zone of the corpus callosum (Fig. 10).

The child gained weight during his hospital stay, which was uneventful. He was discharged to the outpatient clinic on Aug. 15, 1942. He was rehospitalized from March 8 to March 16, 1943, for further study because of repeated convulsive seizures.

*Comment:* We believe that this case presents the findings of complete agenesis of the corpus callosum. It is the only case in our series with other demonstrable developmental anomalies.

CASE 2: J. L. D., a 14-year-old boy, was admitted on Nov. 18, 1942, because of convulsions, loss of memory, and paralysis of the left side, of three months' duration. Physical examination showed him to be a fairly well developed and well nourished patient. There was a loss of strength in the left hand; otherwise, the examination was non-informing. All laboratory studies were essentially normal.

Encephalograms made on Nov. 25, 1942, were not entirely satisfactory due to incomplete filling of the ventricular system. There was evidence of separation of the lateral ventricles and some elevation of the third ventricle was noted. No dilatation of the ventricular system was evident. It was suggested that a partial agenesis of the corpus callosum existed. Repeat studies were requested in the hope of more completely filling the ventricular system. These (Dec. 8, 1942) revealed essentially the same findings as those in the initial examination (Fig. 11).

*Comment:* We believe this case presents the encephalographic findings of partial agenesis of the corpus callosum.

## DISCUSSION

A review of the literature on congenital cysts of the septum pellucidum reveals reports of 15 cases that have been diagnosed by encephalography or ventriculography. Our own bring the total to 21. These are listed as to type, and the order of their appearance in the literature, in Table I.

The age incidence for this group varied from six weeks to fifty-two years. Eleven

TABLE I: REPORTED CASES OF CONGENITAL CYSTS OF THE SEPTUM PELLUCIDUM DIAGNOSED BY ENCEPHALOGRAPHY OR VENTRICULOGRAPHY

| Author | Cavum Septi Pellucidi | | Cavum Vergae | | Complete (Both) | |
|---|---|---|---|---|---|---|
| | Communicating | Non-communicating | Communicating | Non-communicating | Communicating | Non-communicating |
| Meyer (6) | 1 | .. | .. | .. | .. | .. |
| Dandy (1) | .. | .. | .. | .. | .. | 2 |
| Van Wagenen and Aird (5) | 3 | 1 | 1 | .. | .. | .. |
| Pendergrass and Hodes (8) | 3 | .. | .. | .. | 1 | .. |
| Tönnis (17) | .. | 1 | .. | .. | .. | .. |
| Berkwitz (15) | .. | 1 | .. | .. | .. | .. |
| Leslie (16) | .. | .. | .. | 1 | .. | .. |
| Echternacht and Campbell | 1 | 2 | 2* | .. | .. | 1 |
| TOTAL....21 | 8 | 5 | 3 | 1 | 1 | 3 |

* One of these (Case 5) was associated with a non-communicating cyst of the cavum septi pellucidi.

cases said to occur in males were found in the available literature. Only 2 are known to have occurred in females. In our own series there were 3 males and 3 females.

No definite statement can be made regarding the incidence of these cysts in normal persons as compared with the mentally deranged. There is no reason to believe that the neurological abnormalities shown in these cases are dependent upon the presence of the cavities.

Only 18 cases of agenesis of the corpus callosum diagnosed by encephalography or ventriculography are reported. Our 2 cases make a total of 20. These cases are listed in the order of their appearance in the literature, and as to classification, in Table II.

TABLE II: REPORTED CASES OF AGENESIS OF THE CORPUS CALLOSUM DIAGNOSED BY ENCEPHALOGRAPHY OR VENTRICULOGRAPHY

| Author | Complete | Partial | Not Determined |
|---|---|---|---|
| Guttmann (10) | .. | .. | 1 |
| Davidoff and Dyke (9) | 1 | 1 | 1 |
| Hyndman and Penfield (11) | 2 | 3 | .. |
| Foerster (24) | 1 | .. | .. |
| Köttgen (23) | 1 | .. | .. |
| Cass and Reeves (18) | .. | .. | 1 |
| Reeves (21) | .. | .. | 1 |
| Kunicki and Chorobski (19) | 1 | .. | .. |
| Gowan and Masten (22) | .. | .. | 1 |
| Goldensohn *et al.* (20) | .. | 1 | .. |
| Derbyshire and Evans (25) | .. | 1 | .. |
| Bunts and Chaffee (14) | 1 | .. | .. |
| Echternacht and Campbell | 1 | 1 | .. |
| TOTAL.....20 | 8 | 7 | 5 |

The age range in reported cases is from six months to twenty-nine years. The age range in autopsy material is reported to be from birth to seventy-three years. There is no evidence of sex being a determining factor. Of the 17 patients for whom the sex is given, 9 were males and 8 females. Both of our patients were males.

## CONCLUSIONS

1. Congenital cysts of the cavum septi pellucidi and cavum vergae of the non-communicating and communicating type, and agenesis of the corpus callosum, either complete or partial, cannot be diagnosed during life except by encephalography or ventriculography.

2. These mid-line anomalies of the brain should be considered as possible causes of obscure cases of epilepsy, abnormal mentality, and other neurological conditions.

3. When communicating cysts of the septum pellucidum are discovered in sagittal projections and are not clearly defined in lateral views, the cavum vergae may be differentiated from the cavum septi pellucidi by the way in which it flares out at its base beneath the lateral ventricles.

4. Six cases of congenital cysts of the

septum pellucidum and 2 cases of agenesis of the corpus callosum are reported, with a review of the literature on these anomalies.

NOTE: Since the presentation of this paper, the authors have seen 2 additional cases of communicating cysts of the cavum vergae and 1 non-communicating cyst of the cavum septi pellucidi.

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# Lesions of the Aqueduct of Sylvius[1]

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THE FIRST CASE of congenital occlusion of the aqueduct of Sylvius was reported by Hilton in 1847. Pancoast, Pendergrass, and Schaeffer have stated in their classic work, "The Head and Neck in Roentgen Diagnosis," that of all of the lesions revealed by ventriculography those obstructing the aqueduct are the most difficult to diagnose. Twining emphasized the danger of being misled by inadequate visualization of the aqueduct and fourth ventricle and discussed the hydrodynamics involved in filling these structures with air.

Complete replacement of cerebrospinal fluid with air is seldom possible by ventricular puncture in the presence of a blocked ventricular system. The difficulties encountered, therefore, are largely technical and involve positional manipulation of the available air to establish the point of occlusion of the system. However, there are also the possibilities of an incomplete block of the aqueduct and unsatisfactory visualization of an air-filled aqueduct due to superimposed structures that obscure it. The roentgenologist is so often called upon for aid in establishing the preoperative diagnosis by air studies of the ventricular system that it seems justifiable to discuss the difficulties encountered in this procedure.

The roentgen diagnosis is dependent upon failure to visualize the aqueduct, together with the positive findings of obstructive hydrocephalus, namely: (1) symmetrical dilatation of the lateral ventricles; (2) dilatation of the foramina of Monro; (3) dilatation of the third ventricle; (4) dilatation of the aqueduct rostral to the point of obstruction. These criteria may be established by conventional positioning in most cases in which an adequate replacement of fluid by air is effected by the neurosurgeon. In some cases, however, the superimposed bony structures of the cranium or air in dilated lateral ventricles may obscure the region of the aqueduct, necessitating the use of body-section roentgenography. Mid-line lateral laminagrams will give clear visualization of the aqueduct and third and fourth ventricles in such cases. In all instances of failure to visualize the aqueduct or fourth ventricle by conventional roentgenography, we resort to laminagraphic sections in both lateral and frontal projections.

The use of heavy opaque media to demonstrate the point of obstruction, as recommended by Olivecrona, Lysholm, Freeman, and others, is not without risk and has not been regarded favorably by our neurosurgical colleagues. Ventricular injection of lipiodol has been used only once in our clinic for corroboration of the point of occlusion of the aqueduct of Sylvius.

Definite localization of the site of obstruction in obstructive hydrocephalus is of paramount importance. A surgical decision to explore the lesion above or below the tentorium may rest largely upon the ventriculographic findings. An erroneous diagnosis, leading to ill-advised suboccipital decompression and exploration of the posterior fossa, may prove disastrous in a patient with a high aqueductal occlusion. Similarly, a supratentorial exploration will accomplish little for the patient with a subtentorial posterior fossa lesion. A negative exploratory procedure in either case may seriously jeopardize the chance for survival.

In a review of our ventriculographic studies in cases of obstructive hydroceph-

[1] From the Department of Radiology, Yale University School of Medicine. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

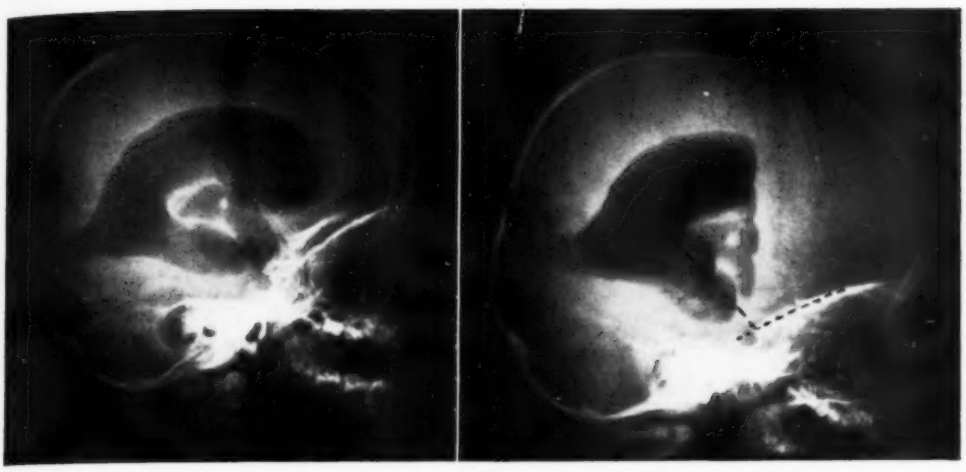

Fig. 1. Infratentorial obstruction of aqueduct by posterior fossa tumor; verified medulloblastoma. Note decreased angle (110°) as compared with the angle in Figure 2.

alus, it was noted by one of us (W. G. L.) that a rotation of the third ventricle on its horizontal axis occurred in a number of instances of subtentorial tumor. In order to evaluate the significance of this finding, we restudied a group of cases of obstructive hydrocephalus. A line was drawn along the base of the anterior fossa, *i.e.*, along the lesser wings of the sphenoid. A second line was drawn from the anterior clinoid process to the suprapineal recess. The measured angle included between these lines was noted in two groups of cases, of proved supratentorial and infratentorial tumors, respectively, and in a control group of normal pneumoencephalograms. It was found that the angle was usually 140 degrees in normal air studies; it was significantly decreased in cases of infratentorial tumors, and was usually increased in non-neoplastic obstruction of the aqueduct above the tentorium. Table I lists the angle measurements in a series of verified lesions producing obstruction of the aqueduct.

TABLE I: OBSTRUCTION OF AQUEDUCT

| Site | Age | Lesion | Angle |
|---|---|---|---|
| Supratentorial | | | |
| Case 1 | 13 | Pinealoma | 140° |
| Case 2 | 11 | Pinealoma | 135° |
| Case 3 | 16 | Stenosis | 150° |
| Case 4 | 19 | Stenosis | 155° |
| Case 5 | 8 | Stenosis | 150° |
| Infratentorial | | | |
| Case 6 | 18 | Astrocytoma | 128° |
| Case 7 | 21 | Astrocytoma | 135° |
| Case 8 | 2 | Astrocytoma | 130° |
| Case 9 | 1 | Medulloblastoma | 110° |
| Case 10 | 3 | Ependymoma | 120° |
| Case 11 | 63 | Hemangioma | 140° |
| Case 12 | 16 | Spongioblastoma polare | 135° |
| Supratentorial and Infratentorial | | | |
| Case 13 | 51 | Metastatic melanoma | 140° |
| Case 14 | 53 | Reticulum-cell sarcoma | 133° |
| Average, Supratentorial Lesions | | | 144° |
| Average, Infratentorial Lesions | | | 128° |
| Average, Non-neoplastic Stenosis | | | 152° |

The usual classification of lesions resulting in occlusion of the aqueduct is (*a*) neoplastic, (*b*) non-neoplastic. The neoplastic lesions may be further subdivided depending upon their origin above or below the tentorium. Occasional instances of multiple tumors will be encountered, with both supratentorial and infratentorial foci.

The material for this study consists of 14 verified lesions in which a roentgen diagnosis of aqueduct stenosis was made. Eleven cases of neoplastic stenosis and 3 of non-neoplastic stenosis were encountered. Seven infratentorial tumors and 2 supratentorial tumors produced obstruction of the aqueduct. Two examples of multiple neoplastic lesions were encoun-

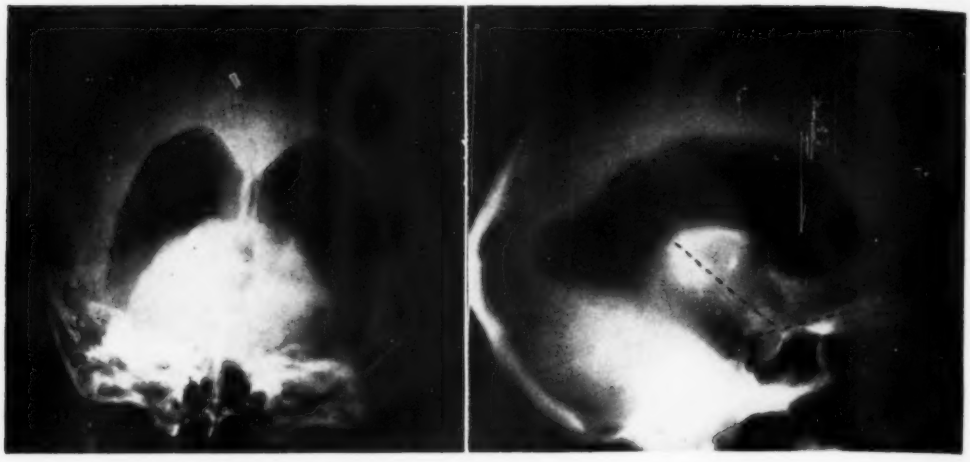

Fig. 2. Supratentorial obstruction of aqueduct and defect of posterior portion of third ventricle due to a pinealoma. Angle of 135° is slightly decreased as a result of the intraluminal defect.

tered, with foci of tumor both above and below the tentorium.

The group of 7 infratentorial neoplastic lesions includes (*a*) 3 astrocytomas, (*b*) a medulloblastoma (Fig. 1), (*c*) an ependymoma, (*d*) an hemangioma, (*e*) a spongioblastoma polare. The clinical findings in all except one of these cases suggested a lesion of the posterior fossa. The ventriculographic studies showed characteristic signs of obstructive hydrocephalus. Two cases of supratentorial lesions were verified pinealomas. The ventriculographic findings are illustrated in Figure 2.

One of the two cases of multiple tumors was verified at autopsy as a reticulum-cell sarcoma involving the cerebrum, cerebellum, and liver. The second case (Fig. 3) was one of malignant melanoma with metastases in both lateral ventricles, third ventricle, aqueduct, and periventricular region of the fourth ventricle. None of the neoplastic lesions in this series is a primary tumor of periaqueductal tissue. Globus, Kuhlenbeck, and Weller state that "true blastomatous lesions arising from cellular elements of the walls of the aqueduct are rare." Four such cases occurred in a series of 250 primary neuro-ectodermal neoplasms. Two of these were hemangiomata, one a pinealoma, and only one a definite neuroglioma that could be traced to the peri-aqueductal tissue.

In our series the occlusion of the aqueduct was proved non-neoplastic in character in 3 cases. Figure 4 illustrates the ventriculographic findings. The presence of a wide angle between the suprapineal recess and the plane of the lesser sphenoid wings was the most helpful criterion observed in the cases of non-neoplastic stenosis of the aqueduct, contrasting well with the normal or decreased angle measured in cases of aqueduct occlusion secondary to posterior fossa tumors. Further observations are necessary to establish the validity of this criterion in differential diagnosis. In contrast to pinealomas, which usually obliterate the suprapineal recess and produce a filling defect in the posterior wall of the third ventricle, simple aqueduct stenosis results in ballooning out of the recess and occasionally in posterior herniation of the third ventricle. It should be mentioned that angle measurements cannot be accurately made and would be unreliable when the suprapineal recess is obliterated. The nature of the aqueductal occlusion, if the patent portion of the aqueduct is visualized, may also give valuable differential aid, inasmuch as non-neoplastic stenosis usually produces a tapering de-

Fig. 3. Supratentorial obstruction of aqueduct by metastatic melanoma. Tumor was found in the third ventricle as well as below the tentorium in the fourth ventricle. Angle 140°.

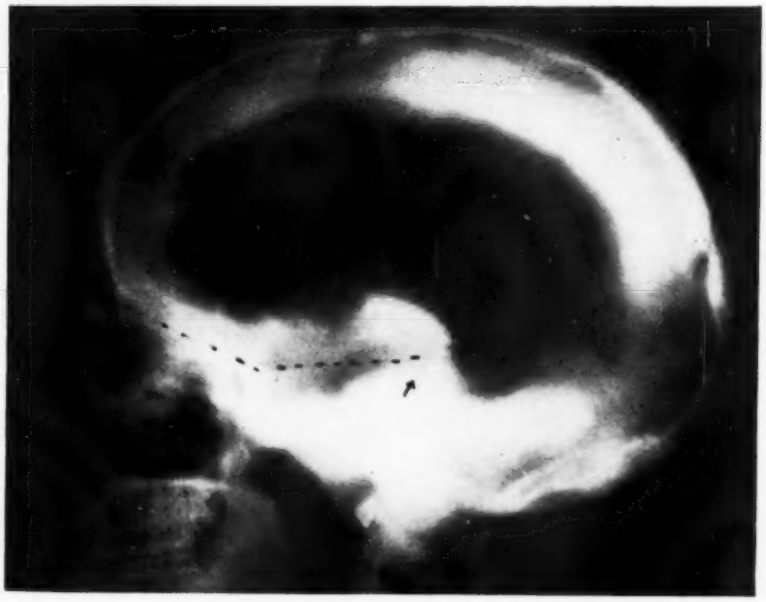

Fig. 4. Supratentorial obstruction of aqueduct by non-neoplastic stenosis. Note wide angle (148°) and diverticulum of third ventricle above and posterior to narrowed iter.

crease in caliber over a rather long segment of the aqueduct, whereas an abrupt occlusion, with dilatation of the rostral end is more characteristically observed in stenosis due to tumors. This is probably the least reliable of the diagnostic features.

The pathological changes in non-neoplastic stenosis are the result of proliferation of normal subependymal glial tissue around the aqueduct. Stookey and Scarff described these changes in 12 of their 16 reported cases.

According to Pennybacker, the subependymal glial cells, and especially their fibrillar elements, seem to proliferate and cause a true stricture of the aqueduct from without, or the proliferation may break through the ependyma to form tufts within the lumen, forming valve-like membranes. The lumen may be split up into a number of tiny channels, invisible to the naked eye, and may then be compared to a swamp, through which cerebrospinal fluid seeps with considerable difficulty.

Two theories have been offered to explain the findings in non-neoplastic stenosis of the aqueduct: (*a*) developmental anomaly and (*b*) intra-uterine infection resulting in secondary proliferation of subependymal glia. Dandy believes the fetal ependyma may be injured by intra-uterine toxic, traumatic, or inflammatory processes with subsequent glial proliferation leading to stenosis. Spiller supports the theory of a developmental anomaly and draws an analogy between the stenosis of the aqueduct and progressive narrowing of the central canal of the spinal cord. He believes the aqueduct may undergo partial or complete closure by early developmental error. He found closure of the central canal of the cord occurring between the ninth and seventeenth years.

Parker and Kernohan have described a group of patients, ages 16, 17, and 19 years, respectively, in whom no hint of the origin of the stenosis was evident. There were no associated developmental anomalies and no history of any preceding inflammatory process. These authors believed that it was necessary to assume that the changes in the aqueduct were due to a process in adult life or to a process developing in an already partially stenosed aqueduct, leading to complete occlusion.

In search for a more satisfactory explanation, we are impressed by the work of Zimmerman *et al.* on lesions of the central nervous system produced by vitamin B deficiency. Zimmerman found changes identical with hemorrhagic pseudo-encephalitis of Wernicke in the brains of persons who died with vitamin B deficiency. He found that this condition had a particular predilection for certain sites in the brain, such as the paraventricular gray matter of the third ventricle, the mammillary bodies, the peri-aqueductal region, the corpora quadrigemina, and the region beneath the ependymal lining of the floor of the fourth ventricle. He was able to prove experimentally, on the pigeon, rat, dog, and fox, that Wernicke's pseudo-encephalitis was definitely associated with chronic vitamin deficiency. The distribution of the lesions in the experimental animal parallel those found in man. The microscopic changes following subsidence of the acute hemorrhagic phase of the disease are those of gliosis and associated increased vascularity. These changes are suggestive of those found in non-neoplastic occlusion of the cerebral aqueduct.

The recent suggestion by Hartley and Burnett that the changes observed in a case of craniolacunia associated with hydrocephalus may be due to deficiency of a factor during early pregnancy, resulting in defective development of portions of the fetal cranium, is interesting. These authors do not describe the autopsy findings in the brain. One would like to know whether the hydrocephalus was due to occlusion of the aqueduct.

In a personal communication, Dr. H. S. N. Greene has described his observations of hydrocephalus affecting approximately 1 per cent of the young rabbits in his rabbit colony. One type of hydrocephalus in certain strains is observed at two weeks of age and leads to a high mortality. A study

of the hereditary factors has shown considerable variation in genetic proportion of involvement in the progeny contrary to mendelian law. During the study, the progeny of rabbits receiving added vitamins in their food during pregnancy showed a marked decrease in incidence of hydrocephalus. Conversely, when the pregnant rabbits received food of inferior quality, without added vitamins, there was a notable increase in hydrocephalus in the progeny, amounting to almost 100 per cent. Vitamin A replacement in part of the colony, without other change in formula, reduced the incidence to the normal regular figure. Although sections of the brains of these animals have so far failed to demonstrate obstruction of the ventricular system or evidence of gliosis, it would seem that a restudy of the problem might be indicated in the light of the deficiency changes observed in human and animal glial tissue by Zimmerman.

In a recent case of craniolacunia associated with meningocele and hydrocephalus, the history of the patient's mother was of special interest. During her first pregnancy, at twenty years of age, the mother was seriously ill with pernicious vomiting of pregnancy throughout the period of gestation. In the child of this pregnancy a spina bifida was noted at birth, and a progressive hydrocephalus developed, with death at fifteen months of age. The second, third, and fourth pregnancies were uneventful except for moderate nausea and vomiting during the first three months, and they terminated in deliveries of normal living children. The fifth pregnancy was characterized by pernicious vomiting throughout the period of gestation and terminated in delivery of a living child. This infant was found to have a lumbar meningocele and craniolacunia, and progressive hydrocephalus developed. Ventriculographic and pneumoencephalographic studies demonstrated symmetrical dilatation of the lateral ventricles and dilatation of the third ventricle. The aqueduct and fourth ventricle were not filled on repeated attempts following both ventricular and subarachnoid replacement of fluid with air. The evidence strongly favored obstruction of the aqueduct and foramina of Luschka and Magendie. The patient's head circumference increased from 34 to 47 cm. in five and one-half months.

The present concepts of non-neoplastic aqueductal stenosis based upon (*a*) developmental anomaly and (*b*) intra-uterine inflammatory lesion healing by gliosis may be correlated. An experimentally induced vitamin deficiency state has been shown to result in localized changes in the periaqueductal tissue. The observed findings in aqueduct stenosis suggest that they might result from a nutritional deficiency developing either during intra-uterine life or later. This hypothesis may also explain the variable age at which such lesions produce symptoms. Until such a relationship can be proved, we will have to retain both of the present theories of pathogenesis.

## SUMMARY

1. The difficulties in roentgen demonstration of occlusion of the aqueduct are reviewed.

2. The differential roentgen diagnosis of supratentorial and infratentorial lesions is discussed and a new roentgen sign is described.

3. Eleven cases of neoplastic stenosis and three cases of non-neoplastic stenosis are reported.

4. The theories of pathogenesis of non-neoplastic stenosis of the aqueduct are reviewed. The role of a nutritional deficiency as an etiological factor is discussed in the light of recent experimental evidence.

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# Observations on the Presence of Subdural Gas After Pneumoencephalography[1]

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THE PRESENT study was undertaken to investigate the significance and mechanism of filling of the subdural space with gas following pneumoencephalography. Several articles concerning this subject have appeared in the literature and are well reviewed by Von Storch and Buermann (10). No systematic study of roentgenograms made twenty-four hours after encephalography has appeared, however, except for a reference by Penfield and Norcross (8). They found that 18 of 22 patients with post-traumatic headaches, on whom second day roentgenograms were obtained following spinal insufflation, showed gas in the subdural space, while only 2 out of 18 controls showed subdural gas. These findings suggested that the demonstration of subdural gas on twenty-four-hour roentgenograms was almost pathognomonic of post-traumatic headache. It should be pointed out, however, that the technic employed in the two groups differed. Our experience with subdural gas was at variance with this conclusion and we felt it necessary to make more extended observations, particularly since we could find no other information in the literature except for a report of 4 cases by Von Storch and Buermann and 2 by Pendergrass and Hodes (7).

## METHOD

For the purposes of this study a series of 78 consecutive pneumoencephalograms was reviewed. No selection of cases was made, the only requirement being that each patient have had upright frontal and lateral roentgenograms made immediately after the introduction of the gas and similar roentgenograms twenty-four hours later. These were studied with reference to ventricular size (lateral ventricles), degree of filling of the subarachnoid spaces, the presence or absence of cerebral atrophy or other recognizable abnormality, and the presence or absence of gas in the subdural space, either under the tentorium or over the convexity of the brain. The present report will deal largely with this latter aspect, *i.e.*, the presence of subdural gas and its possible diagnostic significance.

In addition to objective comparison of the size of the lateral ventricles in the two sets of films, a simple measurement was employed which was found useful in comparing the variations that occurred. This consisted in measuring the diagonal distance through portion three (9) (the central part of the body of the ventricle), as seen in the frontal projection, from the junction of the roof of the ventricle and the septum pellucidum to the height of the convexity of the lateral wall. This measurement was selected since it usually could be made even when the ventricular drainage had been incomplete and it gave a fairly satisfactory index of the degree of ventricular collapse, when such occurred.

The amount of subdural gas, if present, was graded on the basis of 1 to 4. This included both subtentorial and convexity gas, since it can be demonstrated that, normally, free communication exists between all parts of the subdural space, and gas that may be seen under the tentorium in one projection can, with posture, be shifted to various parts of the space.

About half of the encephalograms were obtained by the single puncture and syringe method; for the others, the two-needle method, using a closed system, was

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TABLE I: PRESENCE OR ABSENCE OF SUBDURAL GAS IN IMMEDIATE AND TWENTY-FOUR-HOUR ROENTGENOGRAMS

| Disease Category | Cases | Immediate Films | | Twenty-Four-Hour Films | |
|---|---|---|---|---|---|
| | | No Subdural Gas Cases | Subdural Gas Cases | No Subdural Gas Cases | Subdural Gas Cases |
| Post-traumatic | 14 (18%) | 8 (29%) | 6 (12%) | 3 (13%) | 11 (20%) |
| Tumor or suspected tumor | 8 (10%) | 2 (7%) | 6 (12%) | 2 (8%) | 6 (11%) |
| Cryptogenic epilepsy | 20 (26%) | 4 (14%) | 16 (32%) | 6 (25%) | 14 (26%) |
| Psychosis or psychoneurosis | 3 (4%) | 1 (4%) | 2 (4%) | 1 (4%) | 2 (4%) |
| Other organic disease of central nervous system or diagnosis deferred | 24 (31%) | 9 (32%) | 15 (30%) | 8 (33%) | 16 (30%) |
| Congenital lesions | 9 (12%) | 4 (14%) | 5 (10%) | 4 (17%) | 5 (9%) |
| TOTAL | 78 (100%) | 28 (100%) | 50 (100%) | 24 (100%) | 54 (100%) |

employed. Air was the contrast medium in all cases.

## RESULTS

The immediate and the twenty-four-hour roentgenograms have been studied in a total of 78 cases. Considering first the immediate encephalograms, it was found that 28, or 36 per cent, showed no recognizable subdural gas accumulation, while the remainder (50 cases, or 64 per cent) showed subdural gas either under the tentorium or over the convexity of the hemispheres, or in both locations. An analysis of such subdural filling as seen in various disease states is given in Table I. Subdural filling was encountered in all of the common categories of disease of the central nervous system, and its incidence in these various conditions corresponds closely to the incidence of the disease in the entire series.

An analysis of the presence or absence of subdural gas in the twenty-four-hour roentgenograms, also, is given in Table I. Twenty-four of the 78 cases showed no subdural gas on the second day while 54 showed various degrees of subdural filling. Here again the percentage distribution of subdural filling in the various diseases corresponds closely to their incidence. It seemed apparent at this stage of the study that the mere presence of subdural gas, as shown on the first- or second-day roentgenogram alone, was of no diagnostic significance. Regardless of the clinical diagnosis, it occurred in approximately 64 per cent of the cases immediately after the insufflation of the gas, and in 69 per cent it could be demonstrated at the twenty-four-hour period. Further study of the details of filling of the subdural space then was carried out.

In Table II a comparison is made of the character of subdural gas accumulation on both the immediate and the twenty-four-hour examination. The cases have been classified according to the type of subdural filling, and the incidence of the various diseases for each type of filling is given. Five types of subdural filling could be distinguished. The first type was represented by a group of 16 cases in which there was no subdural gas either at the immediate examination or after twenty-four hours. In a second group, there was no subdural gas at the immediate examination but variable amounts were present at the second-day examination. There were 12 cases in this group. In the third group, of 24 cases, subdural gas was present at the immediate examination and also at twenty-four hours but had increased in amount during the intervening period. The fourth group, of 8 cases, showed the presence of subdural gas on both days without change in the amount. In the fifth group the immediate examination showed subdural gas but this had decreased in amount or had entirely disappeared at the second-day examination. There were 18 cases in this group.

In 48 cases (60 per cent) subtentorial gas was present on the first day, but in only 8 of these was there any gas left under the tentorium on the second-day roent-

TABLE II: TYPES OF SUBDURAL FILLING IN VARIOUS DISEASE CATEGORIES

| Disease Category | No. of Cases | Cases with No Subdural Gas Either Day | Cases with Subdural Gas Both Days; No Change in Amount | Cases with Subdural Gas Both Days; Increased Second Day | Cases with Subdural Gas First Day; Decreased or Absent Second Day | Cases with No Subdural Gas First Day; Subdural Gas Second Day |
|---|---|---|---|---|---|---|
| Post-traumatic | 14 (18%) | 3 (19%) | 0 | 5 (21%) | 1 (6%) | 5 (42%) |
| Tumors or tumor suspects | 8 (10%) | 2 (12%) | 2 (25%) | 2 (8%) | 2 (11%) | 0 |
| Cryptogenic epilepsy | 20 (26%) | 2 (12%) | 3 (38%) | 6 (25%) | 7 (38%) | 2 (17%) |
| Psychosis or psychoneurosis | 3 (4%) | 0 | 1 (12%) | 0 | 1 (6%) | 1 (8%) |
| Other organic disease of central nervous system or diagnosis deferred | 24 (31%) | 6 (38%) | 2 (25%) | 8 (33%) | 5 (27%) | 3 (25%) |
| Congenital lesions | 9 (12%) | 3 (19%) | 0 | 3 (13%) | 2 (11%) | 1 (8%) |
| TOTAL | 78 (100%) | 16 (100%) | 8 (100%) | 24 (100%) | 18 (100%) | 12 (100%) |
| Incidence of type of subdural filling in series | | 21% | 10% | 31% | 23% | 15% |

genograms and then it was in most instances only a trace. In but one case was the subtentorial gas increased on the second day, while in all the others it was greatly decreased. Subdural gas was never seen under the tentorium on the second-day roentgenograms unless it had been demonstrable on the immediate films. These facts strongly suggest that subtentorial gas is always the result of the introduction of gas into the spinal subdural space. A similar conclusion was reached by Von Storch and Buermann in regard to subdural gas under the basal cisterna. Since there is free communication between all portions of the subdural space above and below the tentorium, there would always remain the possibility that convexity air was of the same origin when gas had previously been present under the tentorium.

In only 12 cases (15.4 per cent) was there any evidence of gas in the subdural space over the convexity of the hemispheres on the immediate roentgenogram, and among these cases there was subtentorial filling in 10. There is a strong suspicion that under these circumstances it was of spinal origin.

On the second-day roentgenograms subdural gas over the convexity was present in 54 cases (69 per cent). In only 12 of this latter group was gas present in the subdural spaces over the convexity of the brain when there had been none either there or under the tentorium on the first day. This constitutes one group in which

TABLE III: CASES SHOWING AN INCREASE OF SUBDURAL FILLING ON THE TWENTY-FOUR-HOUR ROENTGENOGRAM

| Disease Category | Cases | Increased Subdural Gas* on Twenty-Four-Hour Examination | | |
|---|---|---|---|---|
| | | Cases | Per Cent† | Per Cent of Total Cases of Disease |
| Post-traumatic | 14 (18%) | 10 | 28% | 71% |
| Tumors or suspected tumors | 8 (10%) | 2 | 5% | 25% |
| Cryptogenic epilepsy | 20 (26%) | 8 | 22% | 40% |
| Psychosis or psychoneurosis | 3 (4%) | 1 | 3% | 33% |
| Other organic disease of central nervous system, or diagnosis deferred | 24 (31%) | 11 | 31% | 46% |
| Congenital lesions | 9 (12%) | 4 | 11% | 44% |
| TOTAL | 78 (100%) | 36 | 100% | |

* Thirty-six (40%) of the cases showed this type of subdural filling.

† All percentages figured to nearest whole number.

there could be reasonable certainty that the gas had not arisen as a result of direct introduction into the spinal subdural space. The diagnosis in 5 of these cases was a post-traumatic condition and in the others was as follows: psychoneurosis, Alzheimer's disease, cryptogenic epilepsy, epilepsy with arteriosclerosis, cortical atrophy of undetermined origin, hypertensive encephalomalacia, and multiple congenital anomalies of the brain.

In the group of cases showing an increase of subdural filling on the second day over that present on the first day, we may

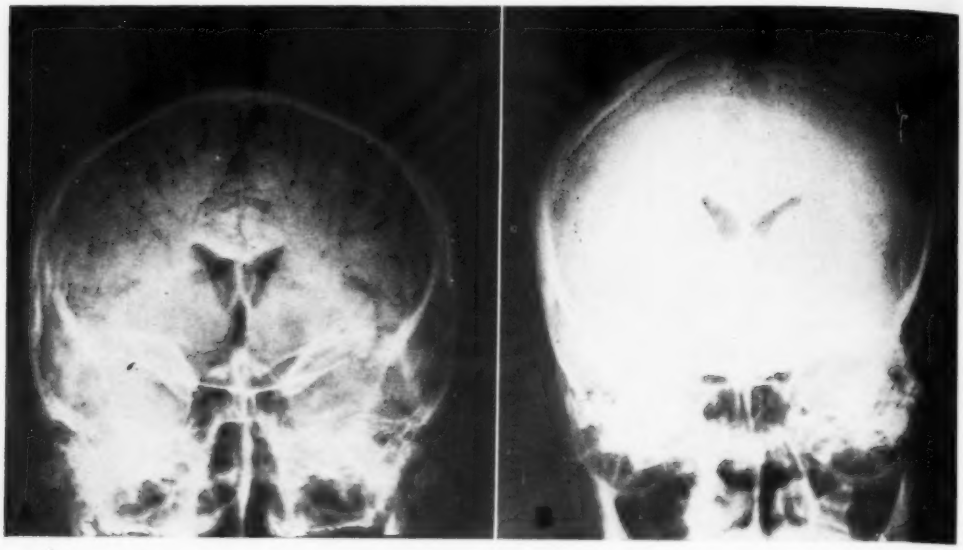

Fig. 1. A. Immediate pneumoencephalogram, showing no subdural gas. B. Twenty-four-hour roentgenogram, showing no subdural gas. Subarachnoid gas has disappeared. Slight collapse of lateral ventricles (ventricular outline retouched).

also assume that the gas was not an artefact of technic but represents the occurrence of a tear or defect of the arachnoid membrane. There were 24 cases showing this type of filling, making a total of 36 out of the entire series of 78 cases (46 per cent) in which the evidence indicates that the gas gained entrance to the subdural space wholly or in part through a tear in the arachnoid membrane. An analysis of these cases is given in Table III. Of interest is the fact that 10 of the 14 post-traumatic cases fall into this category (71 per cent).

Forty per cent of the cases of cryptogenic epilepsy showed this type of subdural filling and it was encountered in 46 per cent of the group of miscellaneous lesions. These latter percentages correspond closely to the incidence of this type of filling in the entire series, or 46 per cent. No conclusions can be drawn from this small series, but the relatively high incidence of post-traumatic cases is noteworthy.

No matter how well filled the subarachnoid space may appear in the immediate roentgenograms, there is seldom more than a trace of gas remaining at the twenty-four-hour study and usually it is all gone. There seems no doubt but that there is direct and rapid absorption of the gas from the subarachnoid space, as was pointed out by Dandy (1) and by Davidoff and Dyke (2). This rapid disappearance occurs whether or not there is gas present in the subdural space. A large amount of gas may be present in the subarachnoid space and be directly absorbed without necessarily causing a tear of the membrane and transit through the subdural space.

The presence of subdural gas on the second-day roentgenograms is not related to the amount of subarachnoid filling on the first day. This is illustrated by comparing two groups of cases, one with no evidence of subdural gas on either day and the other with no evidence of subdural gas on the first day but showing subdural gas over the convexity on the second day. The average degree of subarachnoid filling on the first day was similar in the two groups (2 plus). In other words, the mere presence of large amounts of subarachnoid gas on the first day does not influence the later appearance of subdural gas.

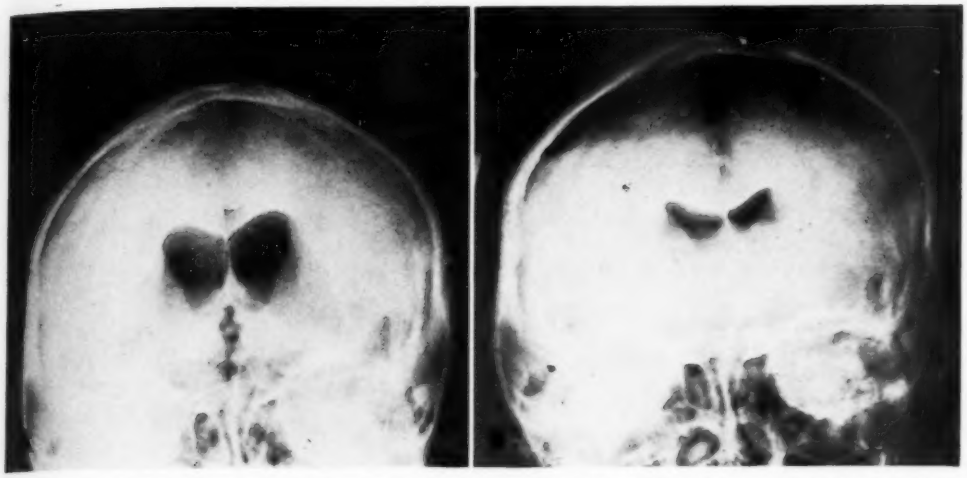

Fig. 2. A. Immediate pneumoencephalogram, showing no subdural gas except for a trace under the tentorium. B. Twenty-four-hour roentgenogram, showing large subdural gas accumulations over convexity, with fluid levels. The decrease in size of the lateral ventricles is striking.

A definite fluid level is not infrequently seen in the subdural space on the second day when there is cerebral atrophy. Presumably there is a flow of fluid through the vent in the arachnoid membrane along with the passage of air. Such a secondary subdural fluid (*ex vacuo*) should be distinguished from a primary subdural effusion. Its appearance depends upon the existence of a certain degree of cortical atrophy with dilatation of the subarachnoid spaces, so that if a tear is produced in the arachnoidal membrane, the subarachnoid spaces collapse and subarachnoid fluid as well as gas passes into the subdural space. It is hardly necessary to point out that surgical drainage of such a fluid collection which appears on the second day is not indicated, since it merely occupies space made available by the cerebral atrophy.

Fig. 2, C. Same case as 2A and B, six days later. Subdural gas has disappeared. Some gas remains in the lateral ventricles and they remain small. Subdural accumulations such as this probably occur as a result of a tear in the arachnoid membrane.

*Ventricular Filling:* The amount of gas in the ventricles and their relative size vary greatly in the first- and second-day roentgenograms. The change in the ventricular silhouette is greatest in the oblique short diameter, suggesting to a certain extent that the ventricle expands and collapses in an accordion-like fashion.

The degree of subdural filling seems to parallel the amount of decrease in size of the ventricular system in those cases where it does not represent a shift of gas previously subtentorial. The ventricular size shows the greatest decrease in those cases with the greatest increase in subdural filling; conversely, there is a relatively small decrease in the size of the ventricles

in those cases which show no subdural filling on either day. This is illustrated by the fact that the measurements of the ventricles decreased on an average of 5 mm. in the first group and decreased an average of less than 1 mm. in the latter group. Nevertheless, there were some instances where a well defined collapse of the ventricles occurred without any convexity gas being present, suggesting that the ventricular collapse is not always due primarily to pressure from the accumulation of gas in the subdural space. Whether the change in ventricular size in these cases is due to fluid accumulation in the subdural or subarachnoid spaces or to increase in brain volume (edema or vascular dilatation) is not clear. The latter is suggested by the symmetry of the decrease when it does occur. In general, the findings would indicate that the subdural air on the second day is derived largely from that previously in the ventricles but do not necessarily imply that it passed directly from ventricles to subdural spaces; rather that it does not linger in the subarachnoid space long enough to be absorbed. This reciprocal relationship between ventricles and subdural filling suggests that gas passes from the ventricles to the subdural space, or rather that ventricular collapse may be one of the chief factors in producing tension on arachnoidal adhesions present over the vertex and so leading to a laceration of the arachnoid and entry of gas into the subdural space.

There were 9 patients who showed no change in the size of the ventricles, while 7 showed an increase in size as indicated by our measurements. Since all the physical factors in taking the films were identical on the two days, this finding could not be denied. Several possible explanations for such an increase in size of the ventricles exist. *First*, gas previously trapped in the cervical region, cisterna magna, the subarachnoid space of the posterior fossa, or even in the third and fourth ventricles, might pass upward into the lateral ventricles. This is clearly the cause in some cases. *Second*, the ventricles might dilate due to the fact that no air leaves them, while at the same time there is a rapid absorption of gas from the subarachnoid space without a commensurate filling of the space with recently formed cerebrospinal fluid. *Third*, there may in some instances be an abnormality in the gaseous interchange between the air in the ventricles and the tension of the gases in the cerebral tissues or blood vessels. *Fourth*, a difference in the intracranial pressure for the two days, and to a lesser extent of the temperature, might alter the gas volume.

Many authors have noted the fact that gas introduced into the dilated ventricles of a patient with hydrocephalus may remain for many weeks, indicating that there is very little if any gaseous interchange through the tissues lining the ventricles in these patients, and the same no doubt may be true of the relatively normal ventricle.

Of the 7 cases that exhibited increase in size of the ventricles on the second-day films, 4 were post-traumatic (one with a 3-cm. skull defect; another with porencephaly). Of the remaining patients, 2 had cryptogenic epilepsy and 1 had Alzheimer's disease.

## DISCUSSION

The significance of filling of the subdural space with gas following encephalography has not been entirely clear. By some authors it has been considered to be due primarily to an artefact of technic. Thus, Pendergrass (6) concluded that in lumbar puncture the point of the needle may come to be within the subdural rather than within the subarachnoid space. After a certain amount of fluid has been withdrawn, the arachnoid collapses and the air is injected directly into the subdural space, from which it passes freely into the intracranial subdural space. A similar mechanism was assumed by Goette (3). There can be no doubt that such a mechanism is frequently operative in producing subdural filling. In our opinion, subtentorial gas is always of this origin, and the same conclusion has been previously reached

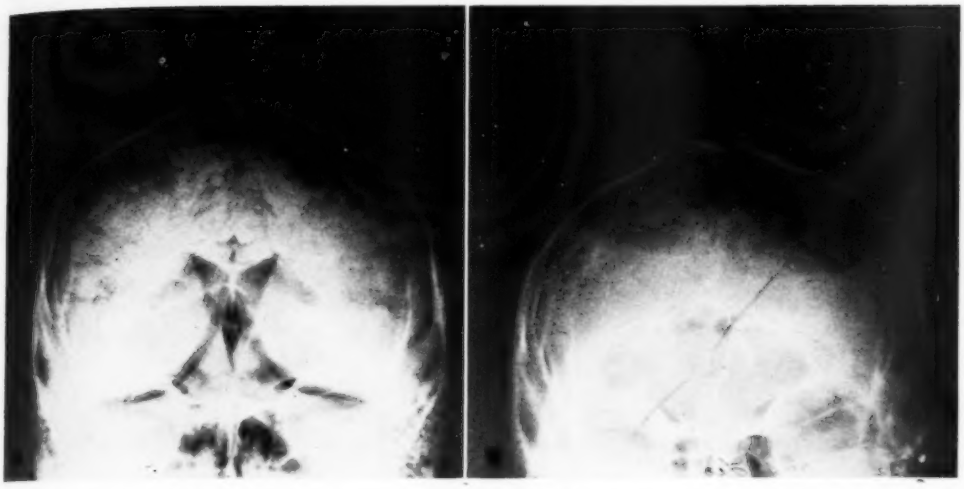

Fig. 3. A. Immediate pneumoencephalogram, showing large subdural gas accumulations under the tentorium; none over the convexity of the cerebral hemispheres. B. Twenty-four-hour roentgenogram. There now are collections of subdural gas over the convexity, while that under the tentorium has disappeared. This may represent only a shift of the gas originally subtentorial, since the amount of gas seems about equal and the gas probably was introduced into the subdural space at the time of injection.

in regard to filling of the basilar portion of the subdural space (Von Storch and Buermann).

The subdural space of the spinal canal differs from that of the cranium in the presence of numerous filamentous adhesions, which are especially numerous in the posterior aspect of the cervical region directly below the foramen magnum (Key and Retzius, 1875) (5). Hemmingson (4) suggested that rupture of the arachnoid membrane may occur at this point. We have seen no evidence as to the occurrence of this phenomenon. There is normally no communication between the subdural and subarachnoid space, so that gas which appears in the subdural space after the initial roentgenograms must do so either by diffusion through the intact arachnoid or as a result of a tear or defect in the arachnoid. It has been demonstrated by Von Storch and Buermann that it is not possible to force air, oxygen, or carbon dioxide through an intact specimen of human arachnoid under pressures ranging from 150 to 450 mm. of physiologic salt solution maintained for twelve to one hundred and twenty-four hours. From their studies it was apparent that when a gas transfers from the subarachnoid to the subdural space, it does so through a defect or tear in the arachnoid membrane. With removal of spinal fluid, the brain was thought to sink toward the base of the skull, producing tension on the arachnoid dural attachments such as are found normally in the region of the pacchionian granulations or elsewhere over the convexity in cases of post-traumatic headache. Our studies indicate that collapse of the ventricles may be a more important factor in producing these tears of the arachnoid which permit the escape of gas into the subdural space. The opposite, of course, may be true, *i.e.*, the ventricles may collapse because of the accumulation of gas over the hemispheres. However, in those cases where the subdural filling occurs on only one side in the twenty-four-hour examination, or where the amount of gas on one side is considerably larger than on the other, the decrease in size of the lateral ventricles does not always parallel the amount of subdural accumulation and may even be greater on the side with the least subdural gas. It is true that unilateral subdural filling at the immediate examination often is associated with depression, distortion, and narrowing

of the homolateral ventricle, but such deformity is less likely to occur in the second-day examinations, perhaps further evidence of the accidental nature of such gas accumulations when found immediately after the spinal insufflation.

The incidence of subdural filling over the convexity on the first-day films in our series was 15.4 per cent, as compared to 7 per cent reported by Davidoff and Dyke and 8.4 per cent by Von Storch and Buermann. Sixty-nine per cent of our cases showed filling of the same area on the second-day films.

Of some interest are those cases exhibiting unilateral filling of the subdural space. As a rule, the amount of gas, especially over the convexity, will differ on the two sides and not infrequently gas may be present on one side only. It seemed to us that posture might have much to do with this inequality. Accordingly, several patients were kept under close observation following the initial procedure of pneumoencephalography until the second-day roentgenograms were taken. Some were kept lying on one side and others were turned freely. In the latter cases subdural gas, when it occurred in the second-day roentgenograms, was always bilateral, while in the former it was found only in the side of the head that had been kept uppermost. Posture, therefore, would appear to have considerable influence upon the location of subdural accumulations and probably is the chief factor in most cases.

The free shifting of gas in the subdural space has been repeatedly demonstrated since we, uniformly, obtain roentgenograms in both upright and recumbent positions during the immediate examination. Thus, subtentorial gas may shift from under the tentorium to the subdural space over the convexity of the brain, and gas in this latter location always tends to accumulate in the uppermost side, depending upon the position of the head.

Two cases were reported by Pendergrass and Hodes (7) in which twenty-four-hour roentgenograms were of inestimable value in disclosing, in one instance, a porencephalic cyst not seen on the first-day roentgenograms, and, in the other instance, filling of only one ventricle on the first-day roentgenograms but of both on the second day. Our experience has been similar, for occasionally porencephalic cysts not seen on the first-day roentgenograms will be clearly demonstrated on the second day. Similarly, the failure of one ventricle to fill should be an indication for second-day studies with posturing of the head so as to promote filling of the ventricle concerned.

## SUMMARY AND CONCLUSIONS

A systematic study of the filling of the subdural space has been made following routine pneumoencephalograms and on roentgenograms taken twenty-four hours later, in an attempt to elucidate the mechanism of subdural filling and its possible diagnostic significance. Subdural filling commonly occurs under the tentorium and the basal cisterna as a result of direct introduction of gas into the spinal subdural space, whence it may also pass in time to the subdural space over the cerebral hemispheres. Under these circumstances, it is obviously an artefact of technic. If one considers only the immediate encephalograms or the twenty-four-hour roentgenograms separately, the mere presence of subdural gas cannot be shown to have any diagnostic significance. The routine study of second-day roentgenograms as well as the immediate encephalograms, however, enables one to distinguish in many cases between such an artefact and the subdural filling which occurs as a result of subarachnoid lacerations. When gas is found in the subdural space twenty-four hours after pneumoencephalography when none had been present in the immediate roentgenograms, or when gas initially present has definitely increased in amount at the end of twenty-four hours, it can be assumed that there must be a tear or defect in the arachnoid membrane which occurred during or after intraspinal insufflation of the gas. Such a finding occurs in a higher percentage of post-traumatic lesions than it

does in the other common categories of central nervous system disease. The presence of subdural gas under these circumstances may support a diagnosis of a post-traumatic lesion or other pathologic process producing adhesions between the arachnoid and dura, but it is not pathognomonic of such a condition.

The presence of subdural gas has no apparent relation to the degree of subarachnoid filling on the first day. On the other hand, subdural filling is greatest in those cases showing the greatest decrease in size of the ventricles on the second as compared to the first day. Ventricular collapse may be an important factor in promoting filling of the subdural space.

The ventricular size and filling are usually decreased on the second-day roentgenograms, but not infrequently an actual increase is observed. The possible explanations of this finding have been discussed.

Roentgenograms taken on the second day after encephalography are also of value for the following reasons:

(1) The shifting of gas from one ventricle to the other or in the subarachnoid or subdural space enables one to judge more accurately the significance of small differences of filling of various structures. Rarely, ventricular filling occurs on the second day when it did not occur on the first day.

(2) Certain pathological structures, notably porencephalic cysts, may be visualized on the second day where their presence was not suspected on the first-day roentgenograms.

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## DISCUSSION

(Papers by Henderson and Sherman, Echternacht and Campbell, Wilson and Lutz, Paul and Erickson.)

**Lt. Comdr. John D. Camp, (MC), U.S.N.R.:** The paper by Dr. Henderson is particularly timely in view of the current interest in roentgenology of the skull. I think it is of the utmost importance, if we are to get the most from roentgenograms of the skull, that we establish more or less definite normals, and this is the largest group that I know of in which an attempt has been made to determine the normal and normal variations of the calvarium. I only hope that Dr. Henderson will carry his observations further in a group of children of different ages, so that the roentgenologist may have a standard for comparison with certain physical measurements, such as the circumference of the skull, to which the pediatrician frequently refers. That there is no constant relation between the volume of the head of the infant and its fetal size seems to me to be an important point, and one which may be of significance for the obstetrician.

Of the mid-line anomalies of the brain presented by Dr. Echternacht, it is, of course, obvious that a high percentage occurred in children. This is as might be expected, since these lesions are of congenital origin. Dr. Echternacht illustrated very nicely that there may also be tumors in this region. Tumors in the midbrain are very difficult for the neurosurgeon to remove. Since many of these lesions are more or less cystic, however, the patient can get some improvement by drainage and by establishment of a communication (if none already exists) between the cysts and the lateral or third ventricle.

I think it is well to point out, as I am sure Dr. Echternacht would have done had he had time, that communicating cysts of the cavum vergae may simulate pinealoma.

The paper by Dr. Paul and Dr. Erickson I think is significant in that it establishes fairly well that the diagnosis of so-called cortical

atrophy must be made with great caution. Several years ago one would make such a diagnosis very glibly, but the studies of Dr. Paul and those of our former colleague, Dr. Dyke, indicate the care that is required for this diagnosis.

The shift of air in the subdural space with the shift of position of the patient indicates the importance of posture and positioning in the procedures of encephalography and ventriculography. After all, these are mechanical procedures and, unless the ventricles and other spaces are thoroughly filled, we may be misled. If the ventricles are not completely filled, we must see that the head is properly manipulated during the examination so that all portions of the ventricular system at least are visualized.

**Merrill C. Sosman, M.D.** (Boston, Mass.): At Harvard, about a year ago, Mr. Churchill spoke of the use and value of Basic English and advocated its further extension. I think the first two papers in this group give us similar indications of the use of Basic Sciences in roentgenology, particularly, in the first paper, of anatomy and embryology. It is certainly true that a thorough knowledge of these sciences often gives the answer to obscure adult cases.

To illustrate, I would like to remind you of the overlapping of the parietal and occipital bones at the mid-line at the lambdoid suture, which often persists into adult life. The presumed fetal molding which causes the overlapping apparently persists here more than at any other place. If seen in the film of an adult who has sustained trauma to the area, this overlap is often interpreted as a dislocation or fracture of the suture in question. If one knows that this occurs in infants and may persist, he may be spared a grievous error.

Another Basic Science is pathology, and Dr. Echternacht has indicated some of the pathological changes that occur in addition to embryological and congenital anomalies.

As an excellent example of the Basic Science of anatomy, which often appears quite different to the radiologist than it does to the surgeon or even to the anatomist himself, I would like to remind you of Davidoff and Dyke's excellent monograph on "The Normal Encephalogram" (1937, Lea and Febiger), which should be in the library of every radiologist who does encephalography or ventriculography.

There is one interesting condition which occurs in association with agenesis of the corpus callosum —benign lipoma. I have seen 3 such cases, all identical. There are others, I am sure, which have not been reported. We have had 3 cases of agenesis of the corpus callosum which have not yet appeared in the literature, and I am sure if all the cases which have been recognized were added to the ones which Dr. Echternacht and his colleagues reported, we would have considerably more than the 20 which he noted. In all probability only 10 per cent of the cases have been reported. There are probably some two hundred which have been recognized by the radiologist or the neurologist before operation or autopsy.

Some of the older members of these Societies will remember an outstanding radiologist who, when he was called on to discuss a paper and even very often when he was not called upon, would get up and show about six cases of what had been presented as a very rare and unusual condition. I am taking the liberty of showing one case. [At this point Dr. Sosman showed several slides.] In the direct lateral view, with no air injection, an area of decreased density exactly in the mid-line of the skull is seen. There are, around this area of decreased density, faint areas of calcification. An anteroposterior view also shows the faint area of decreased density present in the lateral film to be exactly in the mid-line. Now the only thing possible which could give an area of decreased density in the intracranial substance, if no air had been injected—and this is not quite dark enough to be air—would be fat. The only logical diagnosis or assumption, therefore, from a plain x-ray examination like this is that we are dealing with a mid-line lipoma of the brain. I think Dr. Echternacht will agree that the encephalogram is characteristic of agenesis of the corpus callosum. The patient in question suffered epileptic attacks and was also mentally deficient.

Interestingly enough, all 3 of the cases of intracranial lipoma which I have seen—all of them confirmed—have been associated with agenesis of the corpus callosum. So if you have a mid-line lipoma of the brain, I think you may assume that you have associated with it agenesis of the corpus callosum.

The final slide shows a series of intracranial lipomas which have been collected from the literature, indicating that most of these are located in the mid-line. Many of them were small lipomas of no consequence, found at autopsy. We hope to report this group of cases later.

As to Dr. Paul's paper, again the importance is in recognizing subdural air as a normal condition, particularly twenty-four hours after the encephalogram is made. A group of such cases was reported from a psychopathic hospital recently, with the claim that the presence of subdural air was incontrovertible evidence of cortical atrophy in the insane. The authors did not recognize how frequently this observation is made in normal patients.

One final word as a possible addition to this symposium: those of you who deal with these patients realize that many of them have severe headaches after encephalography. These headaches may be promptly benefited and their duration shortened if the patient is given oxygen either in an oxygen tent or by mask. This helps the rapid absorption of intracranial air by its exchange with the oxygen in the blood.

# The Treatment of Late Post-Irradiation Ulcers with Radon Ointment[1]

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THIS REPORT is concerned with the treatment of radiation skin ulcers with alpha particles from radon. The utilization of alpha-radiating agents in post-irradiation ulcers was first suggested in 1925 by Fabry (1–3), who used Thorium X in concentrations from 1,500 to 2,000 electrostatic units per gram vaseline base. The ointment was left in place two to three days, and the treatment was repeated after three to six weeks. The favorable results reported by Fabry were confirmed by Delmes (4), who employed considerably smaller doses (20 e.s.u.). Jessner (5) obtained similarly good results using an ointment containing Thorium X marketed under the name of Doramad and containing 2,000 e.s.u. per gram of ointment. The most extensive studies in the treatment of post-irradiation skin reactions with alpha radiation are those of E. Uhlmann (6–13) undertaken in 1929. The encouraging clinical results demonstrated by Uhlmann convinced us that this method of treatment deserved further study.

Skin changes following radiation therapy have become more common in recent years. The reason for this increased frequency is the far more intensive irradiation employed in the last two decades. The cutaneous reactions which occur as immediate sequelae of treatment, erythema and radio-epidermite, are anticipated as the result of intensive irradiation, while reactions which occur after an interval of about six months are unpredictable. When late sequelae of intensive irradiation occur, they vary considerably in their degree of severity. In the order of frequency of occurrence, they are patchy pigmentation, depigmentation, atrophy, telangiectasia, subcutaneous sclerosis, ulceration, hyperkeratosis. These skin changes have been known since the early days of medical use of x-rays and radium. Originally they could almost invariably be traced to faulty technic, inadequate protection, or to occupational exposure. The great advance in knowledge of radiation physics and biology and the subsequent development of modern technic have provided means of proper protection, but skin reactions persist, necessitating a new approach from both a medical and legal standpoint.

From the legal point of view, the post-irradiation skin reaction should be regarded properly as an unavoidable and unpredictable aftermath of the therapeutic method, unless evidence of negligence or gross lack of knowledge on the part of the practitioner can be shown to exist.

From the medical standpoint, skin reactions occurring immediately after radiation treatment heal spontaneously, as a rule, in four to six weeks after completion of exposure, whereas delayed skin reactions, occurring after about six months or later, may not regress spontaneously and therefore demand attention. Atrophy of the skin and telangiectasia do not require treatment, except for cosmetic reasons. Ulceration and hyperkeratosis must have immediate and special care. The rare occurrence of post-irradiation cancer is beyond the scope of this study.

Medical, surgical, and radiation methods have been used in the treatment of post-irradiation ulcers and hyperkeratoses, with various degrees of success. Each method has its advocates. Little agreement, however, exists on the subject.

Evaluation of the therapeutic methods employed necessitates consideration of the histopathology of the skin changes. The salient feature of late irradiation tissue reactions is impaired vascularity. The degree of the subsequent sclerosis of the skin

[1] Accepted for publication in August 1945.

is determined by the extent of obliteration of the subpapillary capillaries and deep cutaneous vessels. When the disturbed vascular supply is further interfered with by some minor external injury, ulceration follows. Microscopically such ulcerations present the typical signs of tissue necrosis, and the clinical course is identical with that of an indolent ulcer of any etiology. The response of a post-irradiation ulcer to treatment will depend not only on the extent and the degree of impaired vascular supply but also upon the action of the therapeutic agent in separating the necrotic tissue and in assisting the restoration of the blood supply.

When the ulcer extends to bone or involves deep fascial layers, surgical excision of the entire scar and part of the surrounding healthy tissue is the method of choice. The surgeon is often limited, however, by the underlying vital organs and by difficulty in demarcating the extent of the blood vessel changes beyond the visible scar. Occasionally superficial ulcers heal following applications of astringents or protective or tissue-stimulating ointments, such as chlorophyll ointment, aloe vera, and others. More extensive and deeper ulcers are not amenable to this type of treatment.

The variable results of medical and surgical treatment of irradiation ulcers and hyperkeratoses and the recognition of their nature as the outcome of an obliterating endarteritis have encouraged some dermatologists and radiologists to apply radiation to these lesions. The treatment of obliterating endarteritis of any etiology by this means appears justified, since radiation in small doses produces temporary vasodilatation. The vasodilatation increases the blood supply and leads to demarcation of the ulcer, to separation of the necrotic tissue, and finally to healing with a healthy, well vascularized scar.

The indications for radiation therapy of late irradiation reactions were agreed upon by numerous investigators (14, 15), who, however, employed different radiating agents, such as ultraviolet rays, x-rays, gamma rays, alpha particles, and beta particles (16–20). Radon in an ointment base was chosen for use at the University of California because of the physical properties and biological actions of alpha radiation and because of Uhlmann's encouraging results.

In view of the fact that the average range of the alpha particles is 0.135 mm. in tissue (3.9 cm. in air), it might be inferred that only the alpha particles escaping from the most superficial layers (0.01 to 0.05 mm.) would exert biologically effective ionizing action. In the therapeutic use of radon ointment, however, such a calculation is erroneous because of the diffusion of the gas from the vehicle (21–23). It has been shown experimentally that radon is absorbed even through intact skin, and radon can be demonstrated in the blood and exhaled air of patients placed in radon water baths. Thus, in therapeutic applications the effect is not limited to the superficial layers. The radon gas, due to the diffusion from the ointment base and absorption by the skin, reaches the deeper layers as well. These facts indicate that far more alpha particles reach the therapeutic target than can be calculated from the surface or half solid angle effect of a given thickness of the ointment. On the other hand, radon diffuses out of the ointment base gradually; therefore, the effective radiation per unit time is only a fraction of the disintegrating particles contained in the ointment. The total effective radiation is a function of the amount of ointment applied, the amount of radon contained in the ointment, the duration of application, the temperature of the ointment, and the thickness of the layer of the ointment. In clinical applications, this last factor, because of the thin layers used, is negligible.

Happel and Brünauer (23, 24) studied erythema and pigmentation of the skin with radon. They found that applications of radon ointment, 50 to 100 e.s.u. per gram of vaseline, for ten to twelve hours, in some cases caused a distinct erythema and even pigmentation. Uhlmann, however, stated that in his opinion the er-

ythema is due not to radiation, but rather to sensitivity of the skin of some persons to lanolin or vaseline. Our experience in this regard suggests rather that radon in concentrations of 50 to 100 e.s.u. per gram of vaseline may produce erythema. In most of our cases after the third or fourth treatment an erythema was observed. This reaction, as a rule, subsided within eight or ten days. Pure vaseline applied to control areas in these patients produced no erythema.

The objection that the amounts of radiation used in these treatments were too small to produce an erythema becomes invalid when one considers that this treatment utilizes alpha and not gamma radiation. For equal physical exposures, the biological effect of alpha radiation is considerably greater than that of gamma rays, the ratio being approximately 9 to 1 (25). An explanation for this greater biological effect might be the greater density of ionization produced by alpha particles (4,000 ion pairs per micron) as compared with that produced by gamma rays (11 ion pairs per micron).

The radon ointment, said to contain 100 e.s.u. on the day of preparation, was kindly supplied by E. Uhlmann and distributed by the Michael Reese Hospital in Chicago. Recently a radon ointment has been put on the market by the Canadian Radium and Uranium Corporation under the name of "Alphatron." The activity of the ointment is given in electrostatic units.

The definition of the strength of radioactive preparations in electrostatic units is objectionable for at least two reasons: first, very few radiologists are familiar with the definition of radioactivity in these units; second, the ionization method of measuring alpha radiation directly is not accurate. This is especially true when the source of alpha radiation is carried in a vehicle. These reasons are enough to make it desirable to express amount of radioactivity in "curies," where one curie is equal to $3.7 \times 10^{10}$ atoms disintegrating per second, irrespective of the kind of radiation emitted. Converted into these terms, 100 e.s.u. equal 36 microcuries of radon. The obvious advantage of this definition is that it provides a uniform standard for the measurement and expression of radioactivity in any material.

According to the directions of Uhlmann, the radon ointment "should be applied in a 3- to 4-millimeter layer over the altered skin area and covered immediately with a piece of rubber dam, or oil cloth, or cellophane of suitable size. It is held in place by adhesive strips under which absorbent cotton has been placed. The adhesive is laid down in overlapping strips to prevent the escape of the radon into the air. The dressing is left in place for eight hours and then removed by the patient. The treatments are repeated at intervals of seven days. During the interval between treatments the skin must not be irritated by any medication and is best covered by a 10 per cent boric beryllium ointment."

The dose per individual treatment in our cases was the same as that used by Uhlmann. The time necessary to deliver this dose, however, had to be increased to account for the decrease in activity during the time of transportation of the ointment from Chicago to San Francisco. The treatment time varied from ten to eighteen hours.

In general, treatments were given at weekly intervals, as suggested by Uhlmann. In some patients erythema and increased tenderness at the site of application developed after the third or fourth treatment. This was considered as a reaction to the treatment. In the first few cases no change in technic was made. In the later cases, before subsequent treatment was given, the reaction was allowed to subside. This usually required eight to ten days. The treatments were continued until the ulcer healed or the hyperkeratosis disappeared. The total number of treatments in our patients varied from three to twenty-eight. In all patients during the interval between treatments the skin was covered with 10 per cent boric acid ointment.

Airtight latex caps were used to cover the ointment. Latex does not irritate the skin. Caps can be prepared so as to fit

CASE 3: R. I. Female, aged 84, treated with superficial x-rays for squamous-cell carcinoma of the left cheek with regional metastasis. Two courses of treatment were given six months apart: the first course 6,000 r (air), the second 5,000 r (air). Ulcer appeared twenty-six months after the second course. Routine medical treatment of ulcer for six months unsuccessful. Picture No. 1 taken thirty-two months after the second course of x-ray treatment. Picture No. 2 made two months after institution of radon ointment treatment.

CASE 21: C. P. Male, aged 65, received repeated x-ray and radium treatments from 1936 to 1940 for basal-cell carcinoma of right nasolabial fold. Ulceration first occurred in 1940. Picture No. 1 taken February 1943, before institution of radon ointment treatment. Picture No. 2 shows condition after three months of radon ointment treatment.

CASE 23: L. F. Female, aged 25, treated with fast neutrons generated by cyclotron in September 1941, for carcinoma of the left parotid gland. Moderate skin atrophy and telangiectasis followed shortly after therapy. Ulcer appeared twenty-six months after treatment. Picture No. 1 shows ulcer following routine medical therapy methods. Picture No. 2 shows ulcer after a 3-month course of radon ointment treatment.

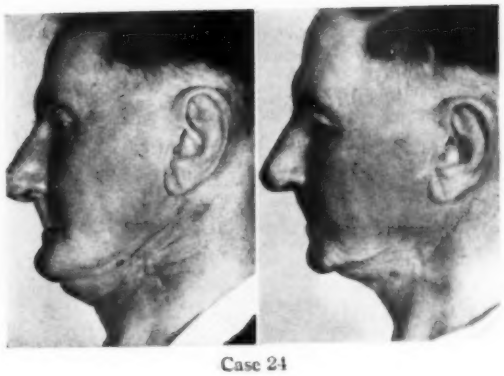
CASE 24: C. M. Male, aged 68, treated with fast neutrons in February 1943, for metastatic carcinoma of the left submaxillary gland. Ulcer developed ten months after treatment. Picture No. 1 shows ulcer after 3 months of routine treatment. Picture No. 2 shows condition after a 10-month course of treatment with radon ointment.

CASE 28: J. W. Male, aged 62, treated with fast neutrons in April and May 1942, for carcinoma of prostate. Ulcer first appeared twelve months after completion of treatment. Routine treatment with boric acid ointment for two weeks. Picture No. 1 and Picture No. 2 show ulcer before and after a three-month course of treatment with radon ointment.

Case 3

Case 21

Case 23



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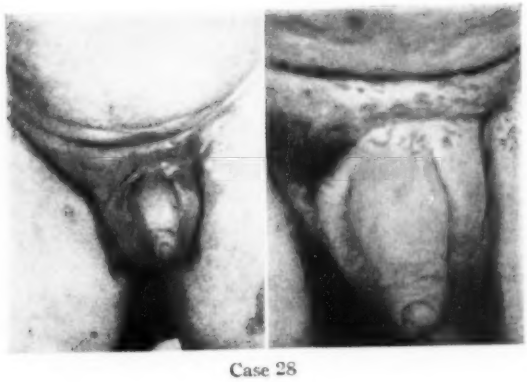

Case 28

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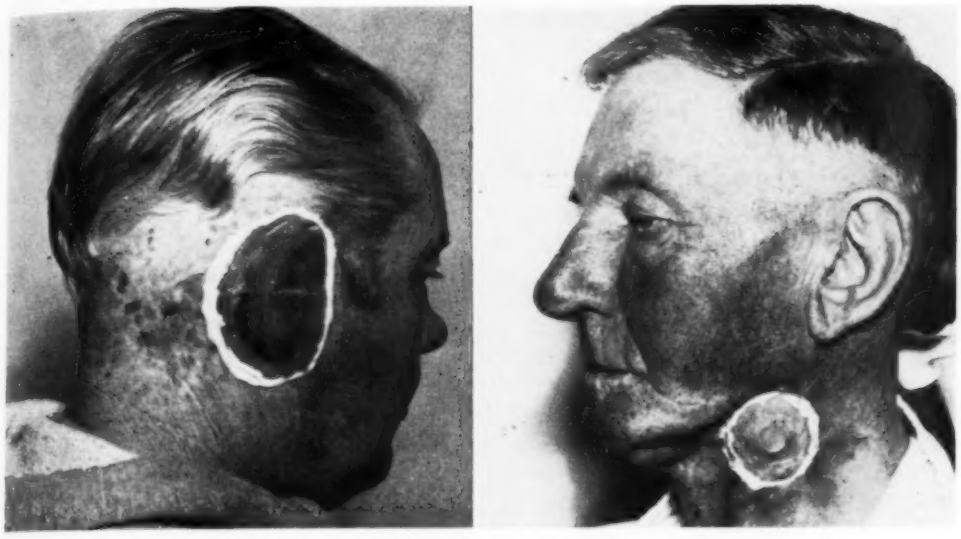

Figs. 1 and 2. Latex caps covering radon ointment.

any part of the body and in any thickness. This method was adopted to prevent the rather extensive skin reactions which had been observed in patients sensitive to adhesive tape. Moreover, we found that in certain parts of the body it was not possible to make an airtight dressing with adhesive tape. The latex caps were prepared through the generous co-operation of Dr. Charles S. Lipp, of the Department of Dentistry of the University of California. Liquid latex is poured over a mold of appropriate size and shape and is left to cure. The latex caps were held in place by liquid adhesive. For patients who exhibit sensitivity to liquid adhesive, the cap can be made thick enough to adhere by suction, and it can be kept in place by an ordinary bandage. It might be mentioned that the passive hyperemia caused by suction may be of additional therapeutic value. (Figs. 1 and 2.)

Latex has been tested for permeability for radon and was found to be radon-tight. Radon ointment was put in a flask-shaped latex container with 3 mm. wall thickness. This was closed with a rubber cork and sealed with liquid adhesive. The sealed latex flask was placed in an airtight box. After twenty-four hours no active deposit was detected on the walls of the box.

All patients with late radiation skin reactions were seen in the Visible Tumor Clinic of the University of California by at least three dermatologists, one surgeon, and one radiologist. Only patients who failed to respond to other medication and were referred upon the consensus of the Visible Tumor Clinic were treated with radon ointment. The history in every instance revealed some minor trauma as immediate cause of ulceration.

In the period from November 1942 to Jan. 1, 1945, 28 patients were treated with radon ointment for post-irradiation ulcers. In Table I, giving the results of treatment, these patients are classified in relation to the type of radiation to which they were primarily exposed: 19 to x-rays, 2 to radium and x-rays, 7 to neutrons.

Of the 19 x-ray patients, 1 had been exposed to diagnostic x-rays, 16 had received x-ray treatments for cancer, and 2 had received repeated x-ray treatments for non-malignant skin disease. The ulcers of *12* of these 19 patients healed completely after one course of radon ointment treatment. The courses varied from two to sixteen

treatments given over a period of from two to twenty weeks. Two patients whose ulcers healed completely after one course had additional radon ointment treatment following recurrence of the ulcers after new trauma. In one of these patients a single additional treatment and in the other patient five more treatments over a period of five weeks were sufficient to bring about the epithelization of the ulcers. *Three* of the nineteen patients showed improvement, but the ulcers have not as yet healed. These patients are still under treatment. *Four* patients of this group showed no improvement. In three of the latter patients the ulcer was proved to be due to malignant growth, and in one patient the ulcer extended to bone.

The ulcers of the two patients who had been exposed to x-ray and radium treatments for carcinoma of the skin healed completely after radon ointment treatment. In one patient who had had a post-irradiation ulcer for fifteen years, nine applications of radon ointment over a period of ten weeks sufficed for healing. In the other patient, who had had the ulcer for several years, seven treatments over a period of twelve weeks brought about complete healing.

In 5 of the 7 patients who had had neutron therapy for a malignant neoplasm the ulcers healed after one course of radon ointment treatment. From three to twenty-eight treatments were given over a period of from four to forty-three weeks. One patient improved only. This patient had been treated with neutrons through two fields for cancer. Eleven months after completion of treatment herpes zoster developed in one of the two fields and its corresponding segment. Some kind of electrotherapy was given to this area, after which five ulcers appeared. Three of these healed, while two only improved, under radon ointment treatment. The treatment had to be interrupted because the patient's general condition became progressively worse. One patient, with an ulcer extending to and involving the bone, showed no improvement.

TABLE I: RESULTS OF RADON OINTMENT TREATMENT

| Radiation Ulcers Following Exposure to | Healed | Improved | Not Improved | Total |
|---|---|---|---|---|
| X-rays | 12 | 3 | 4 | 19 |
| X-rays + Radium | 2 | .. | .. | 2 |
| Neutrons | 5 | 1 | 1 | 7 |

In Table I the outcome of the radon ointment treatment is summarized, while in Table II a short analysis of each case is given.

The outstanding feature of radon ointment treatment in all the patients who responded to it was prompt disappearance of pain. Survey of the case histories indicates that the healing is slow when the ulcer is located in skin regions where there is little underlying subcutaneous tissue and that radon ointment is of no avail when the ulcer extends to tendon or bone.

When inflammation from secondary infection develops in the ulcer, healing is retarded. Nevertheless, the radon treatment should be continued. Between treatments, sulfathiazole ointment or penicillin ointment might be used instead of boric acid ointment. In 2 of our patients, when secondary infection was cleared up, the ulcer healed promptly. Care must be exercised to prevent the development of secondary infection. The latex cap worn even during the intervals between treatments serves as a good protection from injury and infection.

In none of our patients has any untoward effect been noted which could be traced to radon ointment.

## SUMMARY

1. Twenty-eight patients with post-irradiation ulcers have been treated with radon ointment. The length and management of the treatment depended upon the individual case.

2. The radon ointment used contained 36 microcuries of radon per gram of vaseline on the day of preparation.

3. The dose delivered from a given

TABLE II: DETAILS OF CASES

| Case Number Name Age Sex | Location and Field Size Exposed to Radiation | Approximate Extent of Ulcer | Interval from Exposure to Radiation to Appearance of Ulcer and Previous Treatment of Ulcer | Number and Duration of Radon Ointment Treatments | Result and Period of Observation Since Healed | Remarks |
|---|---|---|---|---|---|---|
| 1<br>J. B.<br>47<br>m | Right temporo-occipital, including ear lobe, 15 × 15 cm. | 8 separate ulcers from 0.9 to 1.5 cm. in diameter; 1 hyperkeratosis 0.6 cm. in diameter | 42 months after diagnostic x-rays<br>Sulfathiazole and boric acid ointments, aloe vera, 4 months | 37 treatments<br>18 months | Healed; 5 ulcers 22 months; 1 hyperkeratosis 9 months; 3 ulcers 5 months | Lesions occurred subsequently as grouped, and each was at different location |
| 2<br>G. W.<br>38<br>f | Left chest | 1.5 cm. in diameter | 12 months after treatment with x-rays<br>Boric acid ointment, 2 months | 2 treatments<br>1 month | Healed<br>26 months | |
| 3<br>R. I.<br>84<br>f | Left auricular and mandibular regions, 6 × 9 cm. | 1 cm. in diameter | 26 months after treatment with x-rays<br>Boric acid ointment, 6 months | 7 treatments<br>2 months | Healed<br>15 months | |
| 4<br>C. W.<br>38<br>m | Right cheek, 3 × 5 cm. | 2 × 1.5 cm. | 3 months after treatment with x-rays<br>Boric acid and sulfathiazole ointments, 3 months | 11 treatments<br>3 months | Healed<br>13 months | |
| 5<br>G. B.<br>55<br>m | Dorsum of left hand | 1 cm. in diameter | 5 months after treatment with x-rays<br>Self medication, 5 months | 33 treatments<br>11 months | Healed<br>10 months | 2 courses 6 months apart; after healing following first course, breakdown due to new injury |
| 6<br>K. B.<br>53<br>f | Right chest | 2 cm. in diameter | 12 months after treatment with x-rays<br>Boric acid ointment, 2 months | 23 treatments<br>14 months | Improved | 5 courses, repeated breakdown after primary healing |
| 7<br>C. B.<br>54<br>m | Dorsum of right middle finger, 2.5 cm. | 2 cm. in diameter | 29 months after treatment with x-rays<br>Aluminum acetate cold cream; boric acid ointment, 6 months | 5 treatments<br>5 weeks | Healed<br>16 months | |
| 8<br>O. B.<br>69<br>f | Right side of temple, 6 × 7 cm. | 1 × 1.5 cm. | 5 months after treatment with x-rays<br>Boric acid ointment, 2 months | 16 treatments<br>5 months | Healed<br>21 months | |
| 9<br>E. S.<br>77<br>f | Left ear lobe | 0.5 cm. in diameter | 4 months after treatment with x-rays<br>1% benzocaine and boric acid ointments, 2 months | 12 treatments<br>4 months | Healed<br>11 months | |
| 10<br>A. F.<br>77 | Dorsum of left hand, 2 × 1.5 cm. | 0.3 cm. in diameter | 10 months after treatment with x-rays<br>Self medication, boric acid ointment, 2 months | 29 treatments<br>9 months | Healed<br>13 months | |
| 11<br>T. E. C.<br>66<br>f | Left cheek, 5 × 6.5 cm. | 1 cm. in diameter | 3 months after repeated treatments with x-rays<br>Boric acid ointment, 2 months | 5 treatments<br>6 weeks | No improvement | Active malignant growth proved by biopsy |

*Table cont. on p. 156*

TABLE II: DETAILS OF CASES—*cont.*

| Case Number Name Age Sex | Location and Field Size Exposed to Radiation | Approximate Extent of Ulcer | Interval from Exposure to Radiation to Appearance of Ulcer and Previous Treatment of Ulcer | Number and Duration of Radon Ointment Treatments | Result and Period of Observation Since Healed | Remarks |
|---|---|---|---|---|---|---|
| 12<br>O. J.<br>79<br>m | Left cheek, 3 × 2 cm. | 0.7 × 1 cm. | Approximately 3 years after treatment with x-rays<br>Ointments, self medication, 2 years | 6 treatments<br>8 weeks | Healed<br>15 months | |
| 13<br>C. L.<br>68<br>m | Posterior neck, 10 × 10 cm. | 4 × 8 cm. | 26 years after treatment with x-rays<br>Boric acid and sulfathiazole ointments, aloe vera, 3 months | 13 treatments<br>5 months | No improvement | Ulcer extended to bone |
| 14<br>M. R.<br>39<br>f | Face, 10 × 10 cm. | 0.5 cm. in diameter, on septum of nose | 20 years after treatment with x-rays<br>Ointments, repeated plastic surgery, 5 years | 14 treatments<br>5 months | No improvement | Ulcer was proved to be due to malignant growth |
| 15<br>E. Z.<br>61<br>f | Nose, 4 × 4.5 cm. | 1 × 1.5 cm. | 14 months after treatment with x-rays<br>Boric acid ointment, 3 months | 15 treatments<br>4½ months | Healed<br>4 months | |
| 16<br>L. T.<br>61<br>f | Naso-orbital region, 2.5 cm. in diameter | 0.5 cm. in diameter | 7 months after treatment with x-rays<br>Boric acid ointment, 3 months | 8 treatments<br>2 months | No improvement | Ulcer was proved to be due to recurrence of malignant growth |
| 17<br>E. S. C.<br>43<br>m | Sole of foot | 4 × 5 cm., involving whole heel | 8 years after treatment with x-rays<br>Ointments, sulfathiazole ointment, aloe vera; self medication, 2 years | 25 treatments<br>6 months | Very marked improvement; treatment continues | Amputation of foot was considered by surgeons. This was the most discouraging ulcer in appearance. Present size 1.5 cm., clean, well granulating |
| 18<br>A. C.<br>59<br>f | Dorsum of right hand and forearm | 0.5 cm. in diameter, on dorsum of hand | 10 years after treatment with x-rays and radium<br>Self medication, boric acid and sulfathiazole ointments, 5 years | 9 treatments<br>2½ months | Healed<br>3 months | |
| 19<br>A. F.<br>45<br>f | Anterior abdomen, 15 × 15 cm. | 5 cm. in diameter, periumbilical | 4 years after treatment with x-rays<br>Boric acid and sulfathiazole ointments, 2 months | 23 treatments<br>6 months | Improved; treatment continues | Numerous telangiectases on whole abdomen |
| 20<br>A. C.<br>71<br>f | Left cheek and nasolabial fold, 3 cm. in diameter | 0.5 cm. in diameter | 5 years after treatment with x-rays<br>Ointments and self medication, 25 years | 4 treatments<br>1 month | Healed<br>18 months | |

*Table cont. on p. 157*

amount of radon ointment is not a mere surface effect, but also a function of the temperature-dependent rate of diffusion of the radon from the ointment, the absorption by the skin, and the duration of application.

TABLE II: DETAILS OF CASES—*cont.*

| Case Number Name Age Sex | Location and Field Size Exposed to Radiation | Approximate Extent of Ulcer | Interval from Exposure to Radiation to Appearance of Ulcer and Previous Treatment of Ulcer | Number and Duration of Radon Ointment Treatments | Result and Period of Observation Since Healed | Remarks |
|---|---|---|---|---|---|---|
| 21 C. P. 65 m | Right nasolabial fold, 3 cm. in diameter | 1.7 × 1.5 cm. | Indefinite; had repeated treatments with x-rays and radium since 1936 Ointments and self medication, several years | 7 treatments 3 months | Healed 23 months | |
| 22 F. F. 61 m | Sacrum, 10 × 10 cm. | 4 separate ulcers, 1.5 cm., 3 cm., 1 cm., and 2 cm. | 4 months after treatment with neutrons Boric acid and chlorophyll ointments, boric acid compresses, 4 months | 22 treatments 9 months | Healed 2 months | Patient expired Dec. 10, 1943 |
| 23 L. F. 25 f | Left parotid region, 10 × 10 cm. | 1 cm. in diameter, on left ear | 26 months after treatment with neutrons Boric acid ointment, aluminum acetate, sulfathiazole ointment, 6 weeks | 13 treatments 3 months | Healed 15 months | |
| 24 C. M. 68 m | Left side of jaw and neck, 10 × 15 cm. | 1 cm. in diameter | 10 months after treatment with neutrons Boric acid ointment, 3 months | 28 treatments 10 months | Healed 6 months | |
| 25 W. K. 63 m | Pubic region and root of penis, 10 × 10 cm. | 0.4 cm. in diameter, at root of penis | 24 months after treatment with neutrons Boric acid ointment, 2 months | 3 treatments 4 weeks | Healed 15 months | |
| 26 E. M. 48 f | Left shoulder, 10 × 10 cm. | 5 cm. in diameter, over acromion, exposing bone | 3 months after treatment with neutrons Chlorophyll, boric acid, and sulfathiazole ointments, 5 months | 12 treatments 4 months | No improvement | Ulcer extended and involved bone |
| 27 M. R. 74 m | Paravertebral posterior 10 × 15 cm. | 5 ulcers, 1 to 2 cm. in diameter | 12 months after treatment with neutrons Sulfathiazole and boric acid ointments, 3 months | 25 treatments 8 months | 3 ulcers healed; 2 ulcers improved; 3 months | Treatment interrupted. Patient died of coronary thrombosis |
| 28 J. W. 62 m | Pubic region and root of penis, 10 × 10 cm. | 1 × 0.5 cm., pubis | 12 months after treatment with neutrons Boric acid ointment, 2 weeks | 12 treatments 3 months | Healed 19 months | |

4. Latex caps were used to insure airtight application of the ointment.

5. The reaction occurring after the third or fourth weekly treatment is a true erythema which subsides in eight to ten days.

6. Radon ointment is indicated in any post-irradiation ulcer, is preferable to any other non-surgical method of treatment, and does not interfere with healing if indication arises for surgical intervention.

7. The radon ointment treatment resulted in alleviation of pain and healing of the ulcers, provided there was no extension of the ulcer to bone and that the ulcer was not due to malignant growth.

NOTE: The authors wish to express their appreciation to the members of the Visible Tumor Clinic, to Dr. H. Glenn Bell, Dr. Norman Epstein, Dr. John Graves, and Dr. Frances Torrey, for the aid given in following these patients; to Dr. Charles S. Lipp for his valuable assistance in preparing the latex caps; to Dr. Earl R. Miller for his constructive

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# The Treatment of Hemangioma[1]

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MANY EXCELLENT papers have been written on the treatment of hemangioma. In nearly all of them the advantages of some particular method of treatment have been extolled. This paper is based on experience with 520 cases. Its object is to show the advantage of selecting the form of treatment according to the conditions present.


Fig. 1. Case I: M. B., a girl of 6 months, referred by Dr. M. B. Hartzell of Philadelphia, on Oct. 16, 1918.

A. Cavernous hemangioma involving the left nasolabial fold, treated with a radium plaque made up with four 5-mg. element tubes, with 0.5 mm. silver + 1.0 mm. rubber filtration, applied for one hour. Treatment given Dec. 15 and again on Dec. 18, 1918, for thirty minutes.

B. Child well, July 8, 1919.

C. Perfect result, Nov. 19, 1940, after twenty-two years.

The method of treatment of hemangioma should vary with the type or character of the lesion, its size, its location, and the age of the patient. I am, therefore, not advocating any particular method of therapy for all cases. I shall try to present the indications for each type of treatment, and

Fig. 2. Case II: W. L., female child, age 4 years, referred by Dr. Wm. E. Magaziner of Philadelphia, on July 26, 1927. Cavernous hemangioma of the entire lower lip, treated with a plaque made up with six 10-mg. radium needles, walls 0.4 mm. monel metal, 1.0 mm. brass + 1.0 mm. rubber filtration, at a distance of 2 mm. Surface applications were made for one hour on July 27, Aug. 2, 5, 9, 16, 1927. On Sept. 14, 1927, five 10-mg. radium needles were inserted into the tumor tissue for two hours. Perfect result shown March 1, 1928.

demonstrate some of the results which I have obtained by each. I have found no satisfactory treatment for the portwine type. In these, x-rays have produced atrophy and telangiectasis; radium does the same, and, in addition, the appearance is apt to be blotchy; electrodesiccation gives scarring, and in at least one case I had to treat a keloid afterward.

As radiologists, we naturally think first of treatment with radium and/or x-rays (Andren, Andrews, Pohle, Brown, MacKee, Schmidt, Baensch, Nielsen, Harwell). Hodges has especially recommended treatment as early as possible. In general, and for the greatest number of cases, I believe that radium is the most useful, especially when the lesions are relatively superficial—

[1] Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

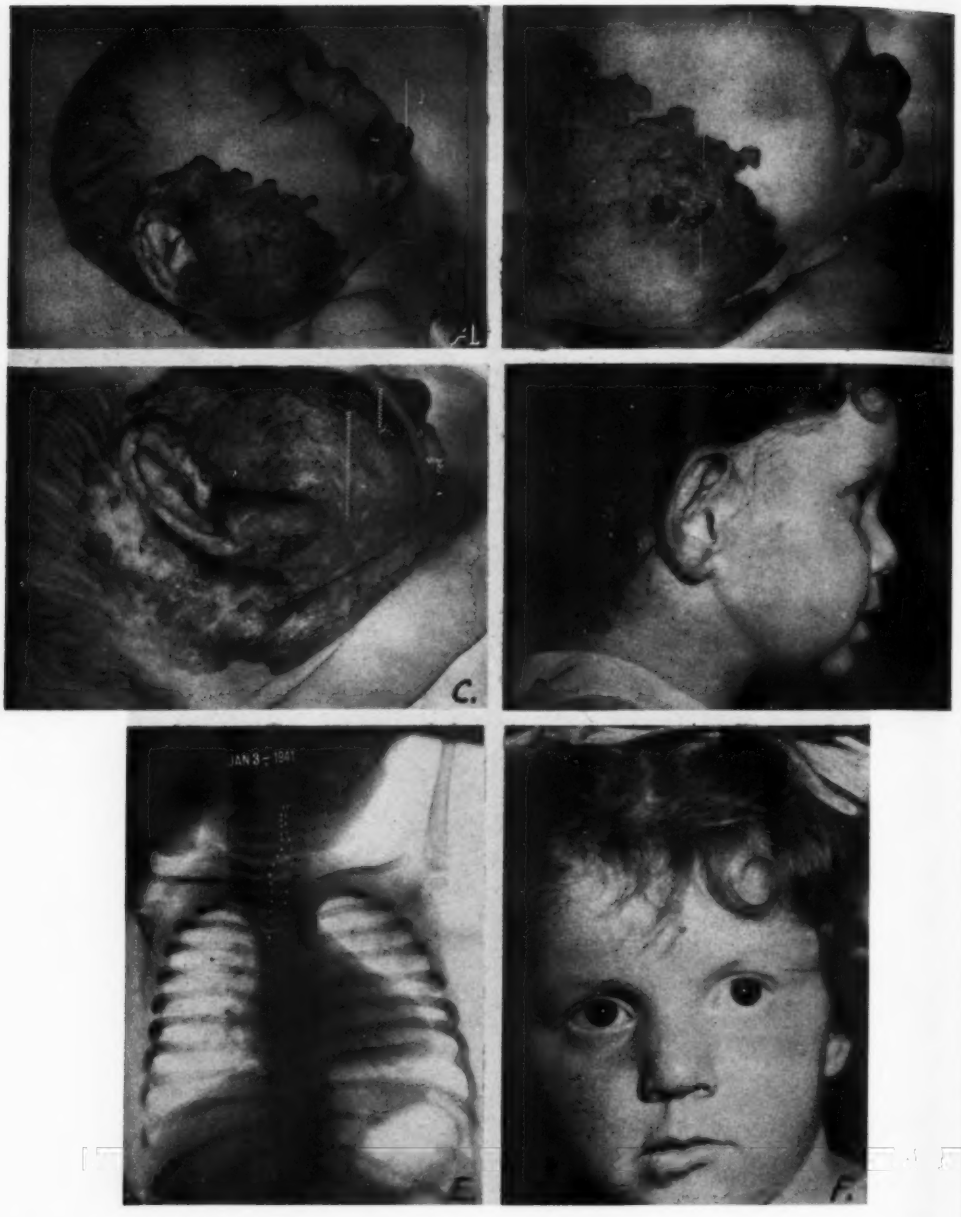


Fig. 3. Case III: J. H., female, age 8 months, referred by W. R. Little of Trenton, N. J., on Jan. 3, 1941. A, B, and C. Cavernous hemangioma involving almost the entire right side of the face, neck, lip, and chin; lesions also on the left side of the scalp and left arm. *None of these was present at birth. The first lesions appeared on the lip at the age of six to eight weeks and on the right cheek at about three months.* They had grown rapidly since. In June 1940, lesions appeared on the left temporal region and on the left arm. The patient was in the Jefferson Hospital in July 1940, under the care of Dr. Warren B. Davis, on account of right middle ear disease, which he treated successfully. While in the hospital, the child began to wheeze, and by bronchoscopic examination Dr. Clerf found obstruction in the trachea due to pressure of a tumor on the right side of the neck. An x-ray film of the chest (E) showed compression by the tumor against the trachea and the larynx, but there was no tumor formation within the chest. The case looked so hopeless that I at first refused treatment. The child was brought back on Jan. 21, 1941, when treatment was urgently requested by the parents. The following radium applications were made:

[*Legend cont. on opposite page*]

not more than 1 or 2 cm. in depth. I have in some cases used both radium and x-rays in the same case. Some good results have been obtained and reported by various authors with each kind of radiation—high voltage and high filtration, low voltage and moderate filtration, and contact therapy with very low voltage and little filtration (Hodges, Kerr, Pendergrass, and others).

### RADIUM: INDICATIONS AND ADVANTAGES

Treatment with radium is indicated especially in children, because it can be applied without pain and without an anesthetic and can be retained by adhesive plaster without immobilizing the patient. In addition, the after treatment requires no dressings and no other special measures. Even in adults, most of these advantages exist. Generally, hemangiomata of the cavernous and strawberry types are relatively superficial. It is to these types that this paper refers. It is always desirable to limit depth dosage as much as possible, when it is not needed. I am convinced that it is neither desirable nor, indeed, entirely harmless to irradiate normal tissue when it can be avoided, and I always try, so far as is possible, to confine irradiation to the diseased tissue. This is why careful diagnosis and good clinical judgment are necessary in radiation therapy, and why it cannot be turned over to technicians. Medical training is essential.

Radium has, relatively, a local and superficial effect. The inverse-square law applies but is complicated by the fact that one must usually use multiple foci. It is my impression that for the treatment of hemangioma, the highly filtered radium rays (gamma rays) give a better cosmetic result. Andrews also is of this opinion. The dermatologic composition plaque can

Fig. 3. Case III.—*cont.*

| Date | Amount | Filter | Distance mm. | Time hr. | Region |
|---|---|---|---|---|---|
| 1-21-41 | 6 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 2 | 1 | Lower lip |
| 1-30-41 | 6 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 2 | 1½ | Lower lip |
| 2-20-41 | 6 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 2 | 1½ | Lower lip |
| 10-31-41 | 3 × 10 mg. | 1 mm. Pt + 1.5 mm. rubber | 2.5 | 1 | Lower lip (outer side) |
| 5-28-42 | 4 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 2 | 1½ | Lower lip (outer side) |
| 10-22-42 | 2 × 25 mg. | 1 mm. Pt + 1 mm. rubber | 1 | 1 | Lower lip (inside) |
| 2-20-41 | 3 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 5 | 2 | Left temporal |
| 2-20-41 | 6 × 10 mg. | 1 mm. Pt + 1 mm. rubber | 5 | 2 | Areas on chin |
| 1-30-41 | 15 × 10 mg. | 1 mm. Pt + 1 mm. rubber + gauze | 7.5 | 1½ | Back of right ear |
| 3-20-41 | 14 × 10 mg. | 1 mm. Pt + 1 mm. rubber + gauze | 5 | 2 | Back of right ear |
| 5-22-41 | 11 × 10 mg. | 1 mm. Pt + 1 mm. rubber + gauze | 5 | 2½ | Back of right ear |
| 5-22-41 | 10 × 10 mg. | 1 mm. Pt + 1 mm. rubber + gauze | 5 | 2½ | Front of right ear |
| 5-28-42 | 5 × 10 mg. | 1 mm. Pt + 1 mm. rubber + gauze | 2 | 1½ | Front of right ear |

In addition to the radium treatment, in order to affect the deep tumor in the neck, which was entirely under the skin, roentgen therapy was given as follows: on Jan. 30, 1941, 200 r and on Feb. 20, 300 r, directed into the posterior portion of the neck toward the tumor tissue (portal, 80 sq. cm., 180 kv., 15 ma., 9 min., 52 cm. distance, 0.5 mm. copper filtration); on Oct. 30, 1941, 300 r low-voltage radiation, directed over the right ear and the right parotid region (5 ma., 8 min., 30 cm. distance, 2 mm. aluminum filtration); on Jan. 21, 1941, 200 r, Feb. 6, 200 r, and March 20, 300 r, directed anteriorly over the trachea and neck (portal of entry, 80 sq. cm., 180 kv., 15 cm. distance, 0.5 mm. copper filtration).

First of all, I made plaques of radium, using 10-mg. units, with 1.0 mm. platinum filtration (= 2 mm. lead). The distance was 2 to 5 mm. but the radium was so placed that an even radiation was obtained, and when the whole area was treated as much as 210 mg. were used. The lip was treated separately. I built a plaque around it, and the other small lesions I treated with small plaques such as are used in dermatology, since the process was relatively superficial. I used low-voltage rays over part of the lip, to get a general effect, and high-voltage rays (200 kv., 0.5 mm. copper) on the neck, because here there was no surface lesion and the object was to get an effect on the hemangioma in the deep tissues, where it was causing compression. I was most fortunate in obtaining a shrinkage of this mass deep in the neck. It is all a matter of choosing rays which will be directed to the area that one wants to affect; but the dosage must be even. One can probably treat these large lesions with roentgen rays, but a more beautiful cosmetic effect is probably obtained with radium.

D and F. At present, we have a healthy child with practically all evidence of hemangioma gone. She has no wheezing or obstruction to breathing. There remains a slight, almost invisible thickening of the lower lip, which will probably shrink further. I usually count on about two years to get the full effect of the radiation.


Fig. 4. Case IV. A. G., female, age 8 months, referred by Dr. C. B. Lerch of Pottstown and Dr. Thomas Butterworth of Reading, on Oct. 16, 1942.

A. Cavernous hemangioma involving the nose and left orbital region. The patient had been treated previously by carbon dioxide snow, which had caused some pallor and scarring on the surface, but the deeper tissues remained. Inasmuch as the lesion covered the eye and involved the lids and the inner canthus, I placed an eye shield under the lid and protected the eye with 1 mm. brass. X-ray treatment was then given with shock-proof equipment (130 kv., 5 ma., 5 min., 30 cm. distance, 2 mm. aluminum filtration) for a 50 per cent erythema dose, or 260 r. This was repeated on Oct. 29, Nov. 12, Dec. 3, and Dec. 22, 1942, and Jan. 26 and March 9, 1943, giving a total dose of low-voltage x-rays amounting to 1,760 r (in air).

B. Shrinkage of the cavernous tumor tissue following treatment; considerable thick, dense tissue still remaining.

C. On April 16, 1943, I introduced into the thickest part of the remaining tumor, in the larger areas, eight 10-mg. radium needles with 0.4-mm. monel metal walls. Four 10-mg. needles with 0.3 mm. iridioplatinum walls, which are of smaller size, were used for the areas of less thickness. The needles were left in place two hours, giving a total dose of 280 mg. hr. On July 27, 1943, fifteen 10-mg. monel metal radium needles were arranged in three plaques and applied at a distance of 5 mm. to the remaining thickened portions. On July 28, four 25-mg. needles were applied for one and a half hours as a surface plaque. There has been no treatment since that date.

D. At present, all evidence of tumor tissue has disappeared, but the scar tissue, which I believe to be due to the carbon dioxide snow, remains. A plastic operation is contemplated.

be used on small and very superficial lesions but I usually use plaques or surface applicators made up of 10 mg. element units, with 1.0 mm. of platinum filtration (= 2 mm. lead). These plaques are made to fit exactly the lesion treated, and have varied from two to thirty-five units (20 to 350 mg.), according to its size. I aim especially to cover the periphery, because of the tendency of hemangioma to extend. In the deeper variety, after preliminary surface irradiation, and when there remains a thick fibrous mass, it is inadvisable to use further surface irradiation (Cases IV and V). I then insert 10-mg. radium needles (2.5 cm. in length with 0.4 mm. monel metal, or 2 cm. with 0.3 mm. iridioplatinum walls). These needles are usually placed 1 cm. apart and left in place two hours. This gives about one-third of the amount of radiation which I would use if the disease were malignant. When making surface application, I usually plan to give approximately 50 per cent of an erythema

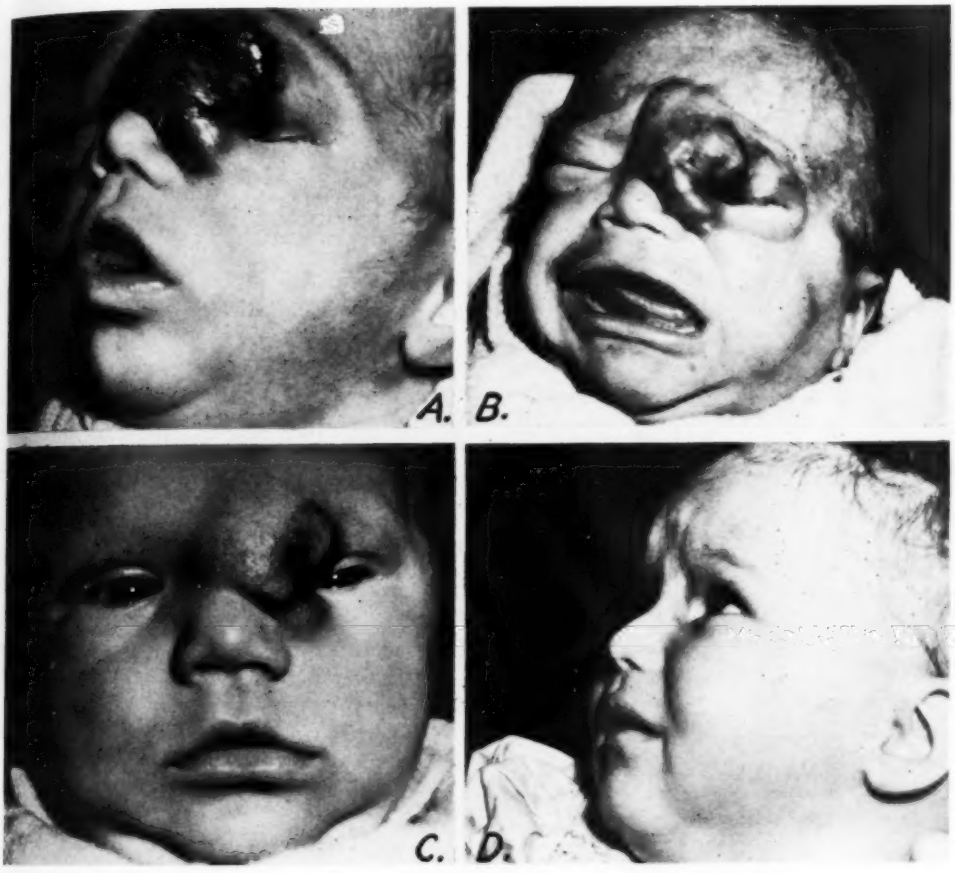


Fig. 5. Case V. C. H., female, age 3½ months, was referred by Dr. J. O. MacLean of Scranton, Penna., on March 10, 1943.

A, B, and C. Cavernous hemangioma involving the forehead and left orbital region. At birth, there was only a small, slightly elevated red mark present. At the beginning of the treatment, the disease involved almost the entire nose and most of the orbit. There was also a smaller lesion on the abdomen. Surface applications of radium were made as follows:

| Date | Amount | Filter | Distance mm. | Time hr. | Region | Mg. hr. |
|---|---|---|---|---|---|---|
| 3-15-43 | 14 × 10 mg. | 1 mm. Pt + 2 mm. rubber + 2 mm. felt | 5 | 2 | Left eyelid, nose, left forehead | 280 |
| 4-15-43 | 11 × 10 mg. | 1 mm. Pt + 2 mm. rubber + 2 mm. felt | 5 | 2 | Left forehead | 220 |
| 4-15-43 | 3 × 10 mg. | 1 mm. Pt + 2 mm. rubber | 3 | 2 | Anterior abdomen | 60 |
| 5-13-43 | 2 × 10 mg. | 1 mm. Pt + 2 mm. rubber | 3 | 2 | Anterior abdomen | 40 |
| 8-1-43 | 6 × 10 mg. | 1 mm. Pt + 2 mm. rubber | 3 | ⅔ | Nose, left eyelid | ... |
| 8-5-43 | 1 × 10 mg. | Plaque 0.13 mm. Pt | ... | ⅔ | Anterior abdomen | ... |
| 11-4-43 | 7 × 10 mg. | Plaque 0.3 mm. Pt | ... | 2½ | Left upper eyelid (needles inserted) | ... |
| 11-4-43 | 4 × 10 mg. | Plaque 0.4 mm. Pt | ... | 2½ | Left finger | ... |

In addition to this, x-ray treatment was given on May 13, July 8, and Oct. 7, 1943 (125 kv., 5 ma., 4½ min., 2 mm. aluminum filtration) for a total dose of 910 r. This was done to obtain a more homogeneous effect.

D. All evidence of tumor tissue has disappeared. The left inner canthus has been crowded outward by the previous tumor. It may be advisable to repair this by a plastic operation at some future date.

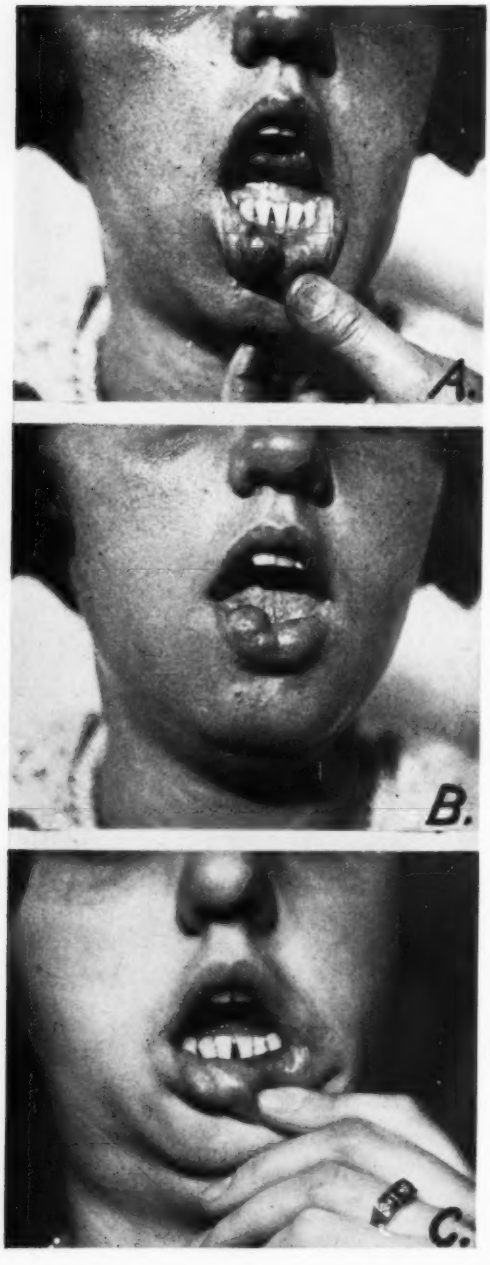


Fig. 6. Case VI. E. D., female, age 20, consulted me on July 26, 1926, on account of a cavernous hemangioma (A and B) approximately 2.5 cm. in diameter, on the inner surface of the right half of the lower lip. This case is reported because the statement has been made that cavernous hemangiomata need no treatment. This patient had received no treatment until she was ten years of age, when one of our leading surgeons cauterized the lesion, but it did not disappear. I applied a 100-mg. plaque of radium, made up with 10 radium needles, each containing 10 mg., with walls of monel metal 0.4 mm. in thickness. To this was added enough rubber to give a distance of 2 mm. This was applied over the tumor on July 26, 1926, for two hours; a 60-mg. plaque, made up in a similar manner, was applied for three hours at a distance of 0.5 cm. on Oct. 25, 1926, and again on Nov. 26, 1926. This caused complete disappearance of the lesion with a perfect result (C).

Other cavernous hemangiomata scattered over the body were treated by electrodesiccation with excellent results. None of these had been previously treated, and *they did not disappear without treatment.*

dose at each application. Perhaps smaller doses repeated more often would be better, but this involves so much trouble and personal exposure in making up the special plaques or applicators, that I aim to do as much with each treatment as is possible. Sometimes I take apart and make over an applicator two or three times before it is just right. For example, in dealing with a cavernous hemangioma in a young child, involving all or part of the lower lip and extending inside as well as outside, one must protect the upper lip, the tongue, the gums, and the tooth germs, and yet apply the radium exactly where it is needed and keep it there. This requires patience, ingenuity, and conscientious work. It is done by cutting and bending one-sixteenth-inch lead to the exact size and shape necessary to hold the radium exactly where it is needed, with the lead toward the gums and tongue, fastening the radium to the applicator exactly as needed, and covering the whole with vulcanized rubber. When radium is used on the eyelids, the greatest care must be taken to protect the eyebrows, the eyelashes, and the eyeball. The eyeball is protected by a special nickel-plated shield, under the lid, or by lead outside the lid, when the latter is not involved.

The distance of the radium from the surface should equal approximately the depth of the lesion. This must be modified and frequently the distance of the plaque must be increased merely to get uniform distribution of the radium from the units. More uniform distribution can also be accomplished by using smaller units and placing them closer together. The time

of application must vary with the distance and one must know or calculate the value of each plaque. When it is necessary to make the application as brief as possible, I sometimes use units of 25 mg., with 1.0 mm. platinum filtration, as in treating the lip of a baby, because of the difficulty in keeping the radium exactly in place and because of the feeding problem.

As to the type of preparation of radium, one must adapt whatever is available. One cannot afford to buy radium in large quantities merely for the treatment of hemangioma. I own 1,250 milligrams and have it divided into very flexible units, so as to make it available for many purposes. However, if one knows the principles governing radium effects and is familiar with the strength and biological effects of the preparations available, it is possible, with ingenuity, to adapt them to the needs of the particular case at hand. Without such knowledge, radium had better not be used. One must always be master of his own equipment, though it need not be exactly like that used by someone else if the principles of irradiation are followed.

Filtration or the quality of radiation from radium I believe to be important, and it is my impression that the gamma rays give the best cosmetic results. Andrews says: "Only brass filtration (2 mm.) has been used during the past five years," and evidently considers the gamma rays best. In addition to the metal filter, I use one or more millimeters of rubber; if more distance is needed, felt or gauze of the proper thickness for the proper distance is useful. For small, very superficial lesions, I frequently use composition plaques such as are used in dermatology, with only 0.13 mm. of Cu plus 1.0 mm. of rubber as filtration. A single application of thirty minutes up to an hour will usually be sufficient with the above filtration, with a plaque on a small lesion.

*Time:* The duration of the application will vary with the strength of the preparation, the filtration, and the distance. In general, I aim to give 50 per cent of an erythema dose. Care must be taken not to overtreat. One should not produce ulceration or desquamation by any method

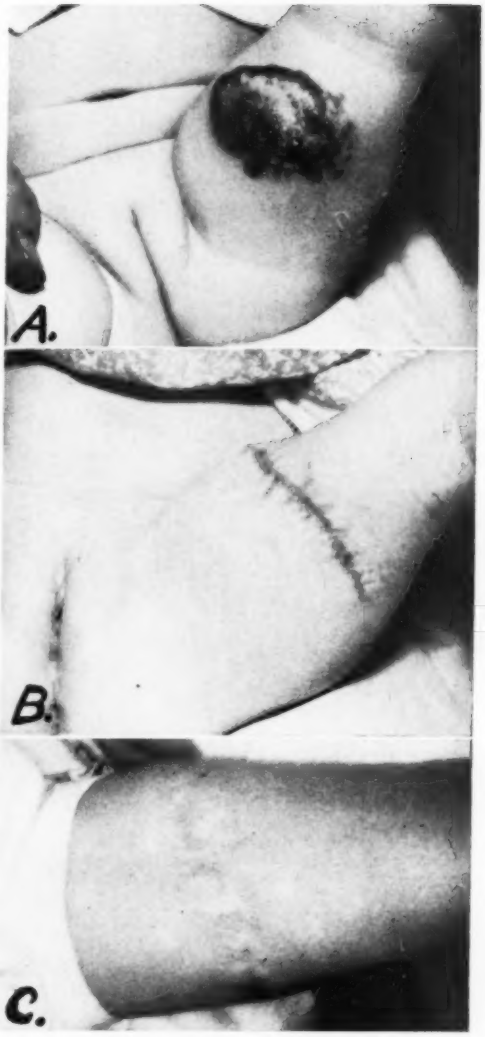


Fig. 7. Case VII. J. H., female, age 11½ months, was referred by Dr. C. F. Stofflet of Pen Argyl, Penna. Cavernous hemangioma (A) approximately 5 cm. in diameter and elevated about 2 cm., occupying the inner side of the upper part of the left thigh. I hesitated to use radium because of the danger that might occur to the ovary, for with radium one cannot absolutely confine the radiation to the lesion. I hesitated to use x-ray treatment for fear of damaging the epiphyses of the left thigh. Therefore, under general anesthesia, I removed the entire tumor area by electrosurgery, then sutured the wound. Primary union was obtained (B). The patient was well June 7, 1939 (C). The microscopic diagnosis was "cavernous and telangiectatic hemangioma."

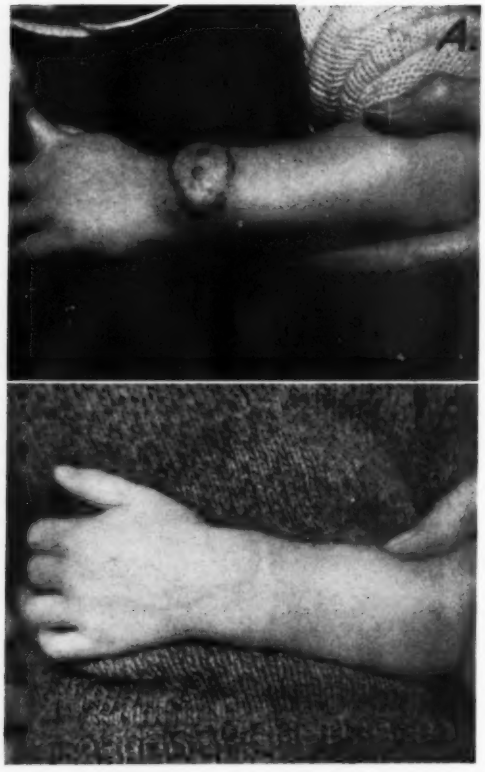

Fig. 8. Case VIII. D. B., female, age 18 months, was referred by Dr. Frank Scudder of Montclair, N. J. She had been treated elsewhere by surface radium applications, six treatments in all, in which 25 mg. were used (5 platinum tubes, with 0.5 mm. thickness). These applications were made at intervals of one week until 100 to 150 mg. hr. had been given.

When I saw the patient, the surface was covered with scar tissue but the periphery was still red, and the tumor was elevated (A). It seemed to be firm and fibrous. I hestitated to use further radium because of the nearness of the lesion to the epiphyses. I referred the patient to Dr. Wm. Bates for surgical removal and an excellent result was obtained (B). This case illustrates the fact that one must adapt the treatment to the conditions present. I gave no treatment myself.

of treatment, for scarring is likely to follow. Scarring will result, too, if carbon dioxide snow has been used previous to the use of radium in the treatment of a thick cavernous hemangioma, and these scars persist after the lesion disappears from the effects of the radium. The interval between radiation treatments should usually be six weeks to three months, for it takes this length of time, as a rule, to get the full effects, and another treatment should not be given until the full effect of the previous one has been obtained. The younger the child, the more rapid will be the results; with early treatment I believe that further extension of the lesion can be prevented.

### RADIUM: DISADVANTAGES AND CONTRAINDICATIONS

(1) Radium must not be used for lesions about or over the testicles or ovaries. In a case in which the lesion covered nearly all of the scrotum, I destroyed the diseased tissue by electrodesiccation, obtaining a perfect result. (2) A small lesion on the scalp can better be destroyed by electrocoagulation, both because of the difficulty in confining the radiation to the lesion, or keeping the radium in place, and because of the danger of destroying hair follicles over a wider area than by electrodesiccation. When the lesions on the scalp are large, one must run the risk of local alopecia following radium applications. In one case which I shall demonstrate this did not occur. (3) Radium application over the epiphyses of the fingers and toes may interfere with development of the length of the bones. I have treated such cases with radium because there seemed no better alternative. The time is still too short to know whether damage has been done. Andrews had one case in which there was local interference with bone growth. The temporary results in my cases have been satisfactory. In a case involving the entire forearm (Fig. 10) I used electrocoagulation followed by skin-grafting. This method was chosen because I feared damage to the epiphyses. (4) Radium treatments usually require a number of visits and a year or more to accomplish satisfactory results. Therefore, when conditions are suitable, it may be simpler and easier, and require less time, to use electrosurgery and suturing of the wound (Fig. 7).

### TREATMENT BY ELECTRODESICCATION

Electrodesiccation, *i.e.*, the use of the small high-frequency spark through air and not in contact with the lesion, is done

under local anesthesia. It is indicated when the lesions are small, superficial, and located where a slight scar is not objectionable. This is the same type of lesion which can be successfully treated by carbon dioxide snow or dermatological composition radium plaques. A small scar on the scalp or a superficial scar on the scrotum is not objectionable—or, at least, is a lesser evil—while a scar on the eyelids may cause contraction. I have found electrodesiccation especially useful in the destruction of the *hairy and warty birthmarks*, particularly on the scalp (Fig. 11). When electrodesiccation is used on the scalp, one should separate the skin from the periosteum so that it will not be damaged by the spark. Otherwise, necrosis of the external table and sequestration will follow. This separation of the lesion from the scalp is easily accomplished by the injection of novocaine *under* and around the lesion.

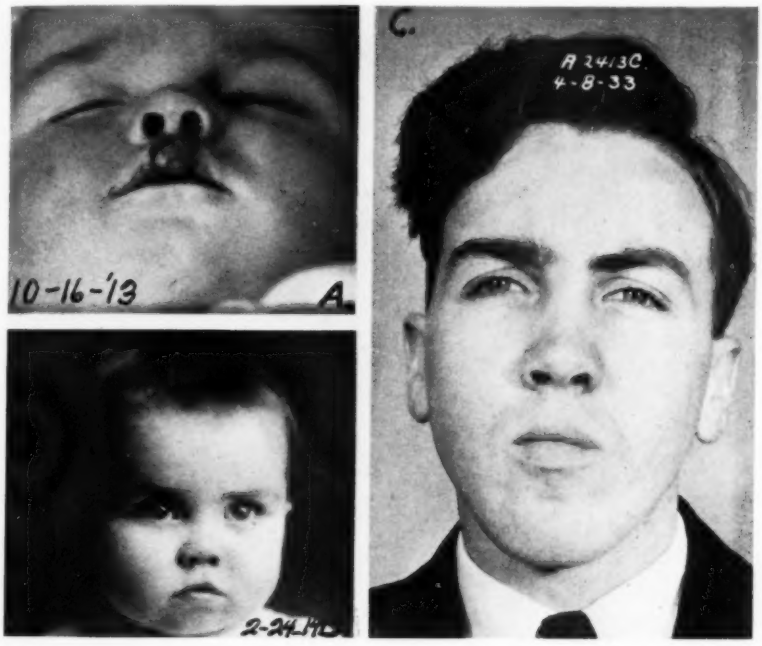


Fig. 9. Case IX. S. P., male, age 1 year, referred on Oct. 16, 1913, with a cavernous hemangioma approximately 1.5 cm., located in the center of the upper lip (A). This was destroyed by electrodesiccation under novocaine anesthesia, showing a perfect result after four months (B). This was maintained twenty years later (C).

In the use of electrodesiccation, the aim should be to destroy only the hemangioma, avoiding destruction of the deeper and healthy tissue, for the deeper the destruction, the more scarring will result. Superficial and incomplete destruction of a cavernous hemangioma will also cause scarring of the skin, even if the effect has not been deep enough actually to destroy the lesion. The result is an ugly white scar on the surface, with a bluish red tumor underneath. Skill and good judgment are essential in this method of destruction.

## ELECTROSURGERY

Electrosurgery in the treatment of cavernous hemangioma consists in the use of the high-frequency bipolar cutting current. The current should be adjusted so as to cut but not to produce a flame. The wound can then be sutured. So far, in the cases in which I have used this method, I have obtained primary union, no infection, and quite satisfactory results. Electrosurgery

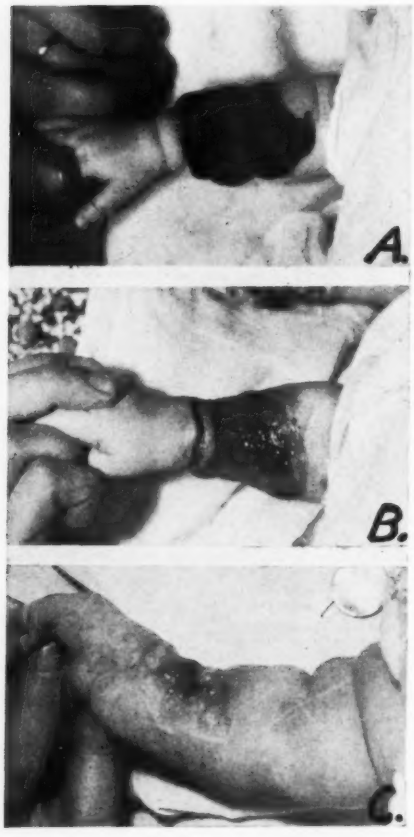


Fig. 10. Case X. M. Y., female, age 2 months, was referred by Dr. J. M. Schildkraut of Trenton, N. J., on Aug. 16, 1932, with a cavernous hemangioma involving the entire right forearm (A). Because of the age of the patient and possible danger to the epiphyses, this was not treated by irradiation. Instead I removed the entire tumor by electrocoagulation. The area was dressed until all necrotic tissue had been thrown off and healthy granulation tissue had formed. Then, on Oct. 5, 1932, at my request, Dr. Wm. Bates did a skin grafting operation with a perfect result, as shown in C, Nov. 9, 1932.


Fig. 11. Case XI. N. M., female, age 13 years, was referred by Dr. Woodward Hudson of Pleasantville, N. J., and Dr. Chas. B. Kaighn, of Atlantic City, N. J., on Oct. 5, 1936, on account of a warty birthmark (A) located above the left ear. It was present at birth but had increased during the past five years. The patient had had some previous x-ray and radium treatment, with no improvement. The disease involved an area, approximately 8 × 6 cm., extending from the parotid region upward over the left ear.

This case is reported because it represents a type that I believe should not be treated by irradiation. I destroyed the entire lesion under local anesthesia by electrodesiccation, obtaining a perfect end-result, as shown in C, Jan. 16, 1937.

is indicated when the lesion is rather large; when it is supported by a good layer of subcutaneous tissue; when the surrounding tissue is sufficiently movable to allow suturing; when time is of importance; and when irradiation may do damage to epiphyses or to the gonads (Fig. 7).

### TYPES OF HEMANGIOMA

The above discussion applies particularly to the cavernous and strawberry-


Fig. 12. Case XII. B. S., female, age 32 months, was referred by Dr. Otto Goldstein, Dec. 17, 1942. She had a hemangioma involving the entire tongue, particularly the left side (A, A′, B, B′). The tongue was approximately four times normal thickness, and the patient was unable to retract it into the mouth. The tumor contained considerable fibrous tissue. A portion of this warty growth had been removed surgically by Dr. Henry Miller on Aug. 29, 1941, and the wound in the tongue was sutured. This operation was followed by much swelling. Surface applications of radium had been made by Dr. B. P. Widmann, and "contact" roentgen therapy under general anesthesia had been given by Dr. Eugene Pendergrass in January 1942. The tongue became swollen and red after each of these contact treatments, but the tumor tissue had undergone little change.

After conferring with the above-named physicians, I decided, in view of all the circumstances, that it was best to introduce radium needles into the tumor. This was done under Venethene anesthesia. On Dec. 18, 1942, fourteen 10-mg. radium needles in 0.4 mm. monel metal were introduced into the left side of the tongue for three hours. On April 1, 1943, thirteen of these needles were inserted for a period of two hours, making a total of 680 mg. hr. on the left side of the tongue.

Marked improvement followed (C and C′), with the left side becoming almost normal (June 5, 1943), as a result of the needling described above. Further improvement is shown in D′ and D (Dec. 18, 1943) as a result of the treatment described above, plus a roentgen dose of 250 r (125 kv., 5 ma., 6 min., 30 cm. distance, 2 mm. aluminum filtration) on Nov. 12, 1943. This roentgen treatment was repeated on the date of the photograph, Dec. 18. The left side of the tongue is now nearly normal, and can be completely retracted into the mouth.

Some increase in the hemangiomatous condition of the right side of the tongue and floor of the mouth was apparent March 16, 1944 (E). On this date, under general anesthesia, the diseased tissue was destroyed by electrodesiccation. Eight 10-mg. radium needles were then inserted into the right side of the tongue for two and a half hours. The tongue was fully retracted and practically normal on May 23, 1944 (E′). At that date, the lower teeth had been pressed forward by the previous enlargement of the tongue, so that they projected beyond the upper teeth. Under repeated pressure during the next four months, these teeth have receded almost normally. The right side of the tongue is now practically normal (F and F′), as are the teeth and mouth.

mark hemangiomata or birthmarks affecting the surface of the body. Electrodesiccation is also applicable to nevi, both the pigmented and the hairy types. Radium and x-rays are not satisfactory in the treatment of the thickened, warty, and hairy types (Fig. 11). I have had no experience in the treatment of *hemangioma of bone*, though it seems to me that high-voltage roentgen therapy would be useful. Good results have been reported in hemangioma of the spine by Ghormley, Stehr, Ferber, Schlezinger, and Thomas. Since surgery is serious, but the only alternative, it would seem advisable to try irradiation in all such cases, and allow enough time to see results.

The essential factors used in treating the illustrative cases are given briefly in the legends.

## SUMMARY AND CONCLUSIONS

1. Hemangioma is a disfiguring and distressing blemish in a child. The cavernous and strawberry types respond satisfactorily in nearly all cases to irradiation therapy and therefore should be treated as early as is practicable. I have found no series of cases reported in the literature in which the lesions have disappeared spontaneously. One finds only an occasional statement that this may occur. I have never seen it. Therefore, one should not wait for spontaneous cures.

2. The portwine type of hemangioma has not responded to irradiation. At present, it seems best to cover this type with cosmetic.

3. The type of irradiation as reported in the literature and used with success has varied from 50-kv. contact roentgen therapy to 200-kv. with filtration through 0.5 mm. copper, and to gamma radiation from radium. The gamma radiation seems to give the most uniformly good cosmetic results, and I prefer it.

4. Good results have been reported with carbon dioxide snow and injection. I have used electrosurgery and electrodesiccation with good results in selected cases.

5. Good results have been reported following high-voltage irradiation of hemangioma of the vertebrae.

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# The Value of Stereoscopy in Mass Radiography of the Chest[1]

IRA LEWIS,[2] M.D., and RUSSELL H. MORGAN,[2] M.D.

THE DIAGNOSIS of disease by general radiographic methods involves two fundamental processes. The first concerns the detection of an abnormal condition and constitutes that portion of the examination in which the film is carefully scanned in an effort to discover unusual roentgen patterns. The second process concerns the identification of disease and forms that part of the examination in which the abnormal patterns, having been found, are scrutinized and their characteristics evaluated in order to establish the nature of the lesion.

In these two processes, stereoscopy may be of considerable assistance. This is particularly so in the identification phase, where the localization and improved visualization of the roentgen changes afforded by stereoscopy are useful in reaching a pathological diagnosis. It is not surprising then that stereoscopy has become a well established procedure in general radiology.

The situation regarding stereoscopy in mass radiography of the chest, however, is much less well defined. Here the emphasis is almost solely on the detection of disease, with the identification process being reserved until a study has been made of full-size 14 × 17-inch films in one or more projections. This fact obviously reduces to some extent the need for the stereoscopic technic in this type of examination.

Stereoscopy will exhibit its greatest usefulness in mass radiography in those cases in which an existing lesion is so small that it may be hidden by a rib or clavicle and therefore overlooked. Opinions regarding the incidence of such cases among the general population vary between rather wide limits, some radiologists believing that a sizable proportion of minimal tuberculous lesions will be undetected unless stereoscopy is employed in the small film examination and others being equally certain that only a few will be overlooked.

In an effort to resolve this difference of opinion, over 4,000 stereoscopic 4 × 10-inch films of the chest were recently examined by the writers with a view to finding the number of minimal tuberculous lesions that might be overlooked if single instead of stereoscopic films are made in mass chest surveys. This group of films was obtained from several surveys to which the writers had access and included, by deliberate selection, a large number of pathological lesions. Minimal tuberculosis was the process chosen for study not only because of its current significance in case finding but because its localized nature makes it likely that stereoscopy would assist in its visualization more than in that of other lesions. There are, for example, other processes, such as the pneumoconioses, that are difficult to detect radiographically, but these lesions are frequently generalized in extent and therefore are not usually clarified by multiple views.

Within the group of films studied, 609 presented evidence of minimal tuberculosis. Among these, slightly more than a third exhibited small, poorly defined opacities with irregular borders characteristic of so-called exudative tuberculosis and therefore considered worthy of further clinical investigation. The remainder indicated only such changes as fibrotic strands and pulmonary scars and were deemed of little significance. This ratio of significant to non-significant cases is in close agreement with the writers' experience in mass case-finding work throughout the United States. The group, therefore, probably constitutes a representative sample of minimal tuberculous disease in the general population.

[1] From the Radiology Section, Tuberculosis Control Division, U. S. Public Health Service. Accepted for publication in July 1945.

[2] Surgeon (R), U. S. Public Health Service.

Within the group of potentially significant films, only 7 were discovered in which the lesions were seen in one of the stereoscopic views and not in the other. This represents 1.1 per cent of the total number of films exhibiting changes of minimal tuberculosis. In 27 other films, or 4.4 per cent of the total, the lesions were seen to better advantage on one of the stereoscopic pair but were visualized sufficiently well on both views to permit detection regardless of which was chosen for study. As might be expected, the cause of the poorer visualization in many cases was the superimposition of the lesions on rib structures. In other instances variation in projection accounted for the differences observed. In all cases, however, it was more the duplicity of view than the fact that the films were made stereoscopically that seemed to improve perception.

In regard to the films in which one of the stereoscopic pair failed to record the lesion, it is reasonable to say that not all 7 cases would be overlooked in a mass radiographic chest survey if only single films were made, since there is obviously an equal chance that the better of the two views would be obtained. It therefore follows that only 0.6 per cent of cases of minimal tuberculosis (*i.e.*, one-half of 1.1 per cent) are likely to be overlooked if single instead of stereoscopic films are made routinely in mass radiography.

Mass chest surveys conducted by the U. S. Public Health Service and associated groups have shown that approximately 1 per cent of the population has x-ray evidence of minimal tuberculosis. One may therefore expect stereoscopy to be of assistance in the detection of this disease in only 6 per 100,000 individuals examined. This certainly must be considered an insignificant number, especially in view of the fact that the personal error which a physician exhibits when reading chest films of all types (*i.e.*, 14 × 17-inch celluloid, 14 × 17-inch paper, 4 × 10-inch, and 35-mm. films) is, as recently shown by a carefully controlled study (1), many times greater.

Furthermore, since the cost of making stereoscopic films is almost double that of making single films, it is evident that the number of cases of tuberculosis that may be discovered for each case-finding dollar that is spent will be approximately twice as great when single films are made. For example, if 200,000 persons are examined by single films, statistical data (2) indicate that 3,000 cases of tuberculosis of all types (minimal, moderately advanced, and far advanced) will be discovered. If stereoscopy were employed, with the same funds available for the study, only 100,000 persons could be examined, with the resultant discovery of 1,500 cases of tuberculosis plus 6 additional cases which would be detected because of the use of stereoscopy. From a public health standpoint, therefore, the choice of procedures is overwhelmingly in favor of the single film method.

From the foregoing it is clear that stereoscopy adds little to the diagnostic accuracy of mass radiography of the chest. This applies to case finding in hospitals as well as in industry. It is recognized that many radiologists and chest specialists have a strong personal preference for stereoscopy. However, it must be constantly borne in mind that such a preference is based purely on subjective factors. It appears that if the single film technic were used for the detection of disease, and stereoscopy were confined to the identification of lesions discovered by mass radiography, maximum benefits would be derived from the case-finding procedures which are available today.

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# A Comparison of Two Levels of Roentgen and Neutron Irradiation of Normal and Lymphomatous Mice, Using Radiophosphorus as an Indicator of Cellular Activity[1]

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RADIOPHOSPHORUS[2] has been used as a tracer in studies of the phosphorus exchange of normal and lymphomatous tissues of mice (1, 2). It has been shown that the $P^{32}$ uptake by neoplastic tissues is the result of their mitotic activity (3, 4). Amounts of radiation causing a depression of tissue metabolism should also reduce its phosphorus accumulation. In the investigation to be reported here, $P^{32}$ was used in order to compare the effects of neutron and roentgen irradiation upon normal and lymphomatous tissues (5). The measurements of neutron and roentgen radiation were made by Dr. Paul Aebersold.

Two series of experiments were performed. In Series I, 19 Strong "A" female mice were used. Of these, 14 were inoculated with lymphoma subcutaneously on one side only. Twenty days later the mice were divided into five groups and treated as follows:

I. Lymphomatous Mice
Group A: 5 mice.....400 r x-ray (whole body)
Group B: 3 mice.....65 n neutrons (whole body)
Group C: 6 mice
(lymphoma control)...No irradiation

II. Normal Mice
Group D: 3 mice
(normal control).....No irradiation
Group E: 2 mice.....65 n neutrons

Twenty-four hours after groups A, B, and E had been irradiated, all five groups were given $P^{32}$ (0.25 c.c. of an isotonic solution of disodium phosphate containing 4.3 microcuries of $P^{32}$ at *p*H 7 subcutaneously).

TABLE I: PERCENTAGE OF $P^{32}$ RETENTION PER GRAM OF TISSUE 24 HOURS AFTER $P^{32}$ INJECTION AND 48 HOURS AFTER NEUTRON OR ROENTGEN IRRADIATION,* FOR LYMPHOMATOUS AND NORMAL MICE. SERIES I

| Tissue | Group A Lymphoma 400 r x-ray (5 mice) | | Group B Lymphoma 65 n neutrons (3 mice) | | Group C Lymphoma Control (6 mice) | Group D Normal Control (3 mice) | Group E Normal 65 n neutrons (2 mice) |
|---|---|---|---|---|---|---|---|
| | % Retained | % of Control | % Retained | % of Control | % Retained | % Retained | % Retained |
| Tumor | 2.14 | 89 | 1.17 | 49 | 2.40 | .. | .. |
| Liver | 2.27 | 95 | 2.30 | 96 | 2.40 | 2.88 | 2.99 |
| Spleen | 3.0 | 73 | 2.84 | 69 | 4.10 | 3.20 | 2.78 |
| Muscle | 1.63 | 107 | 1.49 | 98 | 1.52 | 2.0 | 2.05 |
| Bone | 2.33 | 89 | 2.64 | 100 | 2.64 | 5.70 | 5.45 |

* Whole body irradiation.

Forty-eight hours after irradiation, the mice were killed. The tissues listed in Table I were ashed in an electric muffle furnace. They were assayed for activity with an electroscope.

In Series II of this experiment, 17 Strong "A" female mice were inoculated with lymphoma subcutaneously on one side only. Twenty-one days later, they were divided into three groups and treated as follows:

| Lymphomatous Mice | Irradiation Administered |
|---|---|
| Group 1: 6 mice (lymphoma controls) | None |
| Group II: 6 mice | 300 r x-ray (whole body) |
| Group III: 5 mice | 50 n neutrons (whole body) |

Eight hours after irradiation, these mice were given $P^{32}$ (0.25 c.c. of an isotonic solu-

[1] Accepted for publication in June 1945. This work was supported by the Columbia Fund for Medical Physics of the Columbia Foundation.

[2] Hereafter called $P^{32}$.

TABLE II: AVERAGE WET WEIGHTS OF TISSUES (IN GRAMS) OF LYMPHOMATOUS AND NORMAL ANIMALS 48 HOURS AFTER ROENTGEN AND NEUTRON IRRADIATION. SERIES I

| Tissue | Group A Lymphoma 400 r x-ray (5 mice) | Group B Lymphoma 65 n neutrons (3 mice) | Group C Lymphoma Control (6 mice) | Group D Normal Control (3 mice) | Group E Normal Mice 65 n neutrons (2 mice) |
|---|---|---|---|---|---|
| Tumor | 1.40 | 1.07 | 3.62 | .. | .. |
| Liver | 1.60 | 1.70 | 1.90 | 1.10 | 1.10 |
| Spleen | 0.26 | 0.17 | 0.59 | 0.22 | 0.14 |

TABLE III: BODY WEIGHTS (IN GRAMS) OF LYMPHOMATOUS MICE IMMEDIATELY BEFORE IRRADIATION AND THIRTY-SIX HOURS LATER. SERIES II

| Control Animals Lymphoma Only | | Lymphoma 300 r x-ray | | Lymphoma 50 n neutrons | |
|---|---|---|---|---|---|
| Before | After | Before | After | Before | After |
| 24.7 | 24.0 | 24.7 | 20.4 | 20.7 | 18.2 |
| 26.3 | 25.0 | 23.7 | 21.0 | 23.4 | 21.6 |
| 26.3 | 25.0 | 27.4 | 23.4 | 21.1 | 18.0 |
| 24.4 | 24.0 | 22.0 | 20.2 | 20.0 | 18.0 |
| 20.0 | 18.3 | 25.1 | 22.0 | 23.6 | 21.3 |
| 22.3 | 22.0 | 23.1 | 20.0 | | |
| Ave. 24.0 | 23.1 | 24.3 | 21.2 | 21.8 | 19.4 |

Series II the depression of phosphorus metabolism was greater than in Series I, although the dosages were of the same order (see Tables I and IV). This effect may be due to the difference in time intervals chosen.

Neutrons appear to be roughly six times as effective as roentgen rays in reducing the phosphorus uptake of the lymphoma. Although the tumors, before irradiation of comparative groups, were essentially the same in size, neutrons possibly caused a greater regression of lymphoma than did roentgen rays (see Tables II and V).

TABLE IV: PERCENTAGE OF ADMINISTERED $P^{32}$ PER GRAM 24 HOURS AFTER INJECTION AND 32 HOURS AFTER NEUTRON OR ROENTGEN IRRADIATION.* SERIES II

*Group I:* Control mice received lymphoma subcutaneously 21 days prior to irradiation of Groups II and III.

| | *Mouse A* | *Mouse B* | *Mouse C* | *Mouse D* | *Mouse E* | *Mouse F* | *Average, %* |
|---|---|---|---|---|---|---|---|
| Tumor | 4.5 | 3.5 | 3.6 | 3.9 | 3.9 | 3.9 | 3.88 |
| Lymph Nodes | 4.8 | 4.7 | 4.6 | 4.2 | 5.4 | 5.4 | 4.87 |
| Spleen | 7.0 | 4.0 | 6.0 | 5.7 | 6.5 | ... | 5.84 |
| Liver | 4.9 | 2.6 | 3.8 | 3.3 | 4.2 | 4.9 | 3.95 |

*Group II:* 300 r x-rays plus lymphoma subcutaneously 21 days prior to irradiation.

| | *Mouse A* | *Mouse B* | *Mouse C* | *Mouse D* | *Mouse E* | *Mouse F* | *Average, %* | *% of Control* |
|---|---|---|---|---|---|---|---|---|
| Tumor | 2.0 | 2.4 | 1.1 | 2.1 | 1.3 | 2.2 | 1.85 | 47.7 |
| Lymph Nodes | 2.7 | 4.5 | 2.1 | 3.3 | 2.1 | 3.2 | 2.98 | 61.2 |
| Spleen | 2.3 | 3.2 | 5.2 | 3.2 | 4.1 | ... | 3.60 | 51.6 |
| Liver | 2.9 | 3.8 | 3.4 | 3.7 | 3.1 | 3.2 | 3.35 | 84.8 |

*Group III:* 50 n neutrons plus lymphoma subcutaneously 21 days prior to irradiation.

| | *Mouse A* | *Mouse B* | *Mouse C* | *Mouse D* | *Mouse E* | *Average, %* | *% of Control* |
|---|---|---|---|---|---|---|---|
| Tumor | 1.9 | 2.3 | 2.0 | 2.6 | 1.5 | 2.06 | 53.1 |
| Lymph Nodes | 4.0 | 4.0 | 4.0 | 5.0 | 4.0 | 4.20 | 86.2 |
| Spleen | 5.5 | 2.3 | 4.4 | 4.0 | 5.8 | 4.40 | 75.3 |
| Liver | 3.2 | 3.1 | 3.6 | 3.8 | 3.9 | 3.52 | 89.1 |

* Whole body radiation.

tion of disodium phosphate at *p*H 7 subcutaneously, containing 7.0 microcuries $P^{32}$). Thirty-two hours after irradiation, the mice were killed. The tissues listed in Table IV were assayed for activity in the same manner as in Series I.

The experiments described above indicate that the accumulation of phosphorus by tumor tissue (lymphoma) is depressed by neutron or roentgen irradiation. In

Liver, spleen, and lymph nodes became infiltrated with the lymphoma used in these studies (5). The data show that the phosphorus uptake of these tissues is depressed (see Tables I and IV). Inhibition of growth of the infiltrating lymphoma cells is also suggested by a reduction in the

TABLE V: AVERAGE WET WEIGHTS (IN GRAMS) OF TISSUES OF LYMPHOMATOUS MICE FOLLOWING NEUTRON AND ROENTGEN IRRADIATION. SERIES II

| Tissue | Control | 300 r x-ray | 50 n neutrons |
|---|---|---|---|
| Tumor | 0.748 | 0.459 | 0.264 |
| Lymph node | 0.253 both sides | 0.084 one side | 0.081 one side |
| Spleen | 0.609 | 0.203 | 0.217 |
| Liver | 1.876 | 1.798 | 1.591 |

wet weights of these tissues (see Tables II and V). The effect of irradiation upon the total body weights of the mice used in Series II is given in Table III. Although some weight was lost, it was relatively much less than that observed in the infiltrated tissues. No definite effect upon the phosphorus metabolism of normal mice was observed when 65 n were given in Series I.

## SUMMARY

Neutrons and roentgen rays depress the phosphorus uptake of lymphomatous tissues in mice as measured by radiophosphorus. By the use of this technic, another method is available for the study of the effects of various radiations on normal and neoplastic tissues.

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# Some Observations on X-Ray Treatment Cones[1]

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IN RECENT years, considerable attention has been given to the matter of providing the radiotherapist with more reliable high-tension generating equipment and x-ray tubes, more accurate physical measurements of the x-ray output, and more trustworthy evaluations of skin dose and depth dose data. With respect to treatment cones, however, it would appear that some improvement is still necessary. Manufacturers have made available a large variety of cones and applicators which in many cases are being used in conjunction with x-ray equipment without full realization of their individual limitations. In particular, the practice of supplying accessories which attempt to provide for all types of therapy (superficial, deep, and cavity) with the one high-voltage therapy unit has resulted in the production of some treatment cones which do not conform to sound physical principles. This report is based on experience gained during the routine calibration of all types of x-ray equipment in Australia. With many of the points raised the radiological physicist is already familiar, but it is felt that emphasis should be laid on the need for more careful design of treatment cones.

Quimby and Marinelli (1), Jacobson (2), and Silverstone and Wolf (3) have all shown the necessity for the photographic examination of the field of a treatment cone. During the initial calibrations of x-ray equipment by this laboratory a routine check by photographic and ionization means is made of the fields produced by individual cones, and it is our impression that little has been done in recent years to improve the general design of cones.

## TYPES OF TREATMENT CONES

In general, treatment cones are provided for attachment either to a master cone or directly to the tube housing. Cones are used for the following reasons:

(1) To maintain a given focal-skin-distance.

(2) To limit the x-ray beam to the particular area which it is desired to irradiate.

(3) To aid in the directioning of the x-ray beam.

(4) To provide compression when deep-seated lesions are being irradiated. If by the use of compression, the distance between the skin and the lesion can be diminished, an appreciably higher dose can be delivered to the lesion for any given value of the skin dose.

Cones can be conveniently classified into two essentially different types, depending on the method by which the area is defined at the cone surface. In the first type (Fig. 1, A) the cone has a large upper aperture and the walls are constructed of radiopaque material (usually lead); this can be called the side-shielded cone. Such cones are supplied with some deep-therapy equipment but are much more generally used in association with superficial and contact therapy apparatus. The second type (Fig. 1, B) has a radiopaque diaphragm at the top with an aperture of the correct dimensions to define the beam at the exit surface of the cone. The walls are constructed of some light material, their only requirement being sufficient rigidity to support the exit surface at a definite distance. This type can be called the top-diaphragm cone. Contrary to the opinion of Silverstone and Wolf that the most satisfactory cones are those in which the field is defined at the skin surface, we have been of the opinion that the top-diaphragm cone is most satisfactory, and only the latter type is now used with deep-therapy equipment in Australia.

[1] Accepted for publication in May 1945.

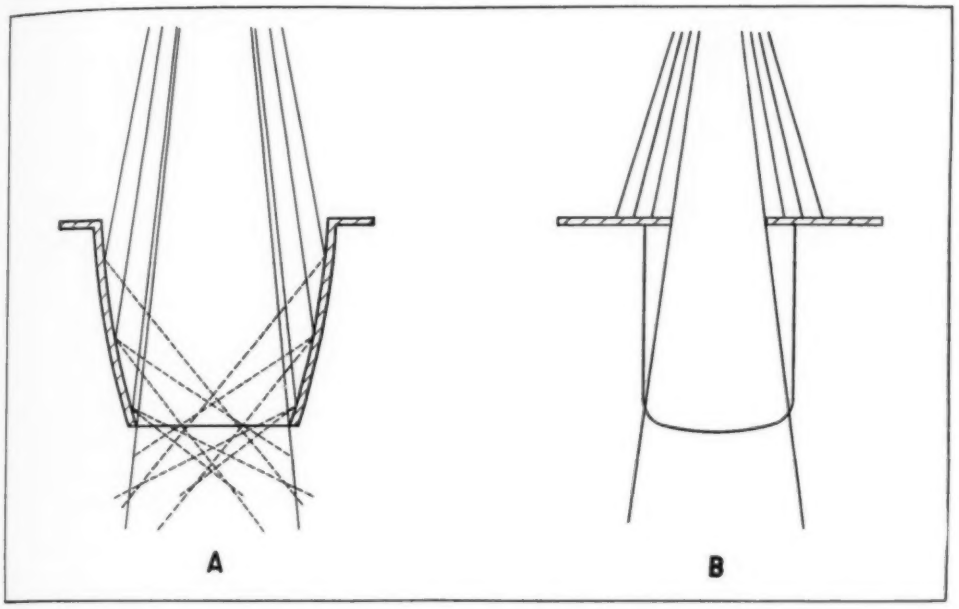


Fig. 1. Typical construction of (A) side-shielded cone and (B) top-diaphragm cone. The radiopaque material limiting the beam is indicated by hatching. The direct radiation is indicated by continuous lines, the scattered radiation by broken lines.

We have, however, recently compared again the two types of cone. Reference to Figure 1, A, will show that the radiation reaching the skin from the side-shielded cone consists of (1) radiation reaching the skin directly from the focal spot (it is this radiation alone which is transmitted by the top-diaphragm cone) and (2) radiation reaching the skin after scattering from the lining of the wall of the cone.

To study the effect of this second component, the limiting diaphragms were removed from two standard treatment cones with areas of 10 × 10 cm. and 4 × 4 cm., respectively, and the walls of the cones lined with lead to define the area of the exit surface. Ionization measurements showed that the radiation reaching the skin after scattering from the walls of the cone was approximately 12 per cent in the case of the 10 × 10-cm. cone and appreciably more with the 4 × 4-cm. cone. This is in general agreement with the results of Silverstone and Wolf, and of Williams (4). By testing the validity of the inverse-square law, however (see Table I), it was shown that this scattered radiation traversed the face of the cone at such angles that the majority of it was outside the direct beam after traveling 3 cm. below the face of the cone. The presence of this additional radiation, although at first sight appearing to have advantages, actually introduces two difficulties. Since it is impossible to place the ionization chamber in the plane of the face of the cone, the evaluation of the x-ray dosage in that plane is deduced from measurements taken at known distances below the

TABLE I: TEST OF VALIDITY OF INVERSE-SQUARE LAW WITH DIFFERENT CONES

| F.S.D. d cm. | Top-Diaphragm Cone | | Side-Shielded Cone | |
|---|---|---|---|---|
| | Free Air Output r/min.(I) | $Id^2$ | Free Air Output r/min.(I) | $Id^2$ |
| 51.5 | 35.2 | $934 \times 10^2$ | 38.1 | $1{,}011 \times 10^2$ |
| 52 | ... | ... | 36.6 | $990 \times 10^2$ |
| 53 | 33.1 | $930 \times 10^2$ | 33.7 | $946 \times 10^2$ |
| 55 | 30.9 | $935 \times 10^2$ | 30.8 | $930 \times 10^2$ |
| 58 | ... | ... | 27.6 | $928 \times 10^2$ |
| 60 | 25.9 | $933 \times 10^2$ | 26.05 | $938 \times 10^2$ |
| 65 | ... | ... | 22.05 | $932 \times 10^2$ |
| 70 | 19.1 | $935 \times 10^2$ | 19.1 | $935 \times 10^2$ |

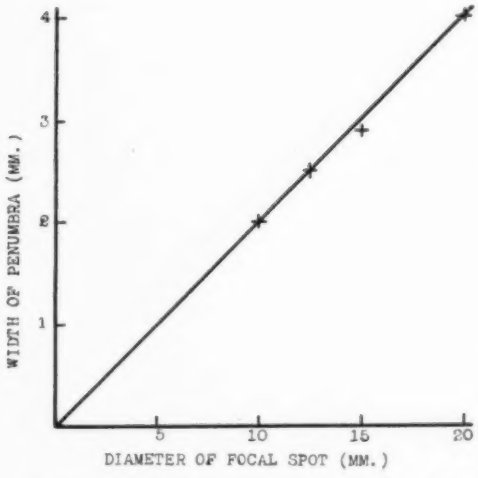


Fig. 2. Variation of width of penumbra with diameter of focal spot for a focal-skin distance of 50 cm., a diaphragm-skin distance of 15 cm., and a treatment port of 10 × 10 cm. Geometrical consideration shows that the width of the penumbra will be different at different edges of the field. That shown (for the edge adjacent to the cathode) has the maximum value.

partures from the law occur. A much more serious difficulty arises, however, in the actual treatment of a deep-seated lesion, since the scattered radiation then only adds an undesirable dose to the skin and superficial tissues and leads to a decrease in the depth dose for any given value of the skin dose. Moreover, it can be shown that the scattered component is definitely softer than the direct radiation, and this fact again leads to additional dosage of the superficial tissues. The proportion of the scattered component will, of course, depend upon the geometrical factors of the cone system. It may be that the soft component is a reason for the lack of agreement between published back-scatter and depth dose data where workers have used cones of different types.

One criticism of the top-diaphragm cone has been the decrease of dosage toward the edge of the cone due to penumbral images.

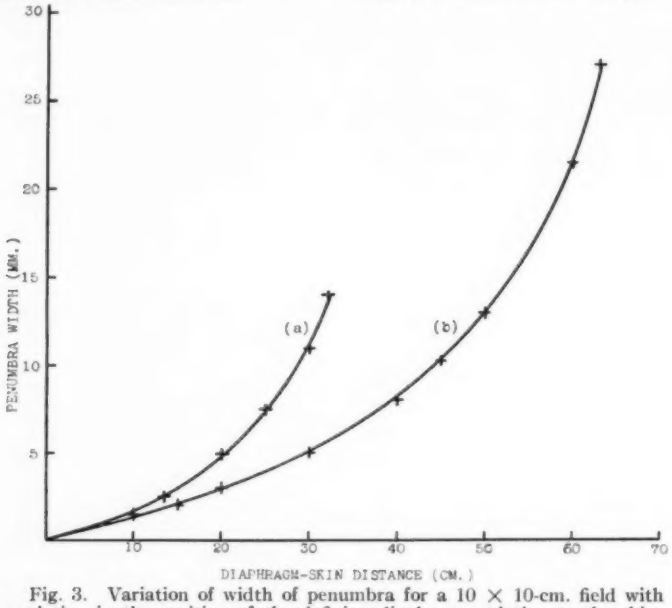


Fig. 3. Variation of width of penumbra for a 10 × 10-cm. field with variation in the position of the defining diaphragm relative to the skin: (*a*) for a focal-skin distance of 50 cm.; (*b*) for a focal-skin distance of 80 cm.

plane. In cases where the inverse-square law is obeyed (as with the top-diaphragm cone) this evaluation can be made with much greater accuracy than where de- In the photographic examinations, it has not been our experience to find any extensive penumbra, but the magnitude of the penumbra is of course determined by the

size of the focal spot, and the relative distances from it of the cone face and the defining diaphragm. Figure 2 shows the variation of the width of the penumbra with variation in the diameter of the focal spot when the diaphragm-skin distance is 15 cm. for a focal-skin distance of 50 cm. and a treatment cone of 10 × 10 cm. In Figure 3 the variation of the width of the penumbra with variation in the position of the defining diaphragm relative to the skin for the same treatment cone is illustrated. It is evident that the width of the penumbra is reduced by reducing the distance between the defining diaphragm and the skin and it would be advantageous to use as short a treatment cone as possible consistent with ease and accuracy in adjusting the cone to the patient. Further, it would appear more satisfactory to use a longer master cone when transferring from 50 to 80 cm. focal-skin distance than to place longer treatment cones on the one master cone. In equipment fitted with an intensimeter, this may necessitate a built-in ionization chamber in each master cone, but with these placed at different distances from the focal spot a check against error in cone selection would be provided.

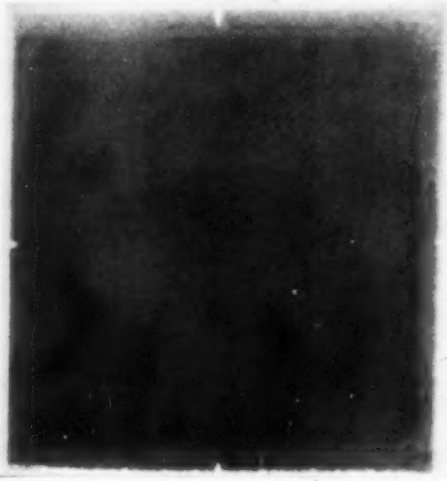

Fig. 4. Field produced by a commercial top-diaphragm cone at 50 cm. The reduced intensity at the edges is due to absorption in the end of the cone.

Fig. 5. Field produced by a commercial cone in which metal fittings of the ionization chamber in the master cone limit the beam. The area of the expected field is shown by the lines.

It can be seen that in any case the area of the penumbra is small compared with the area of the field. It is possible, however, that particular commercial cones produce a field in which it appears that an extensive penumbra is present. The field of a 10 × 10-cm. top-diaphragm cone of this type, with a focal-skin distance of 50 cm., is shown in Figure 4. The reduced intensity at the edges in this case is not due to a penumbral image but to absorption in the frame which supports the end of the cone. When this frame is removed, a central well defined field, with a penumbra of the size to be expected from Figure 3, is obtained.

## PHOTOGRAPHIC EXAMINATION OF FIELDS PRODUCED BY CONES

Whichever type of cone is used, the photographic examination is of considerable value in detecting irregular irradiation fields. When radiographic tubes are used for superficial therapy, it is frequently found that the aperture in the tube wall is sufficiently large that the target face casts an unexpected shadow and so limits the area of the field. In these cases a permanently mounted circular diaphragm

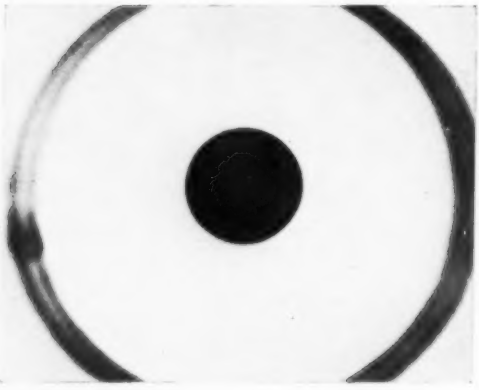

Fig. 6. Leakage of radiation through a badly designed commercial cone.

to define the field of maximum diameter is an advantage. In some deep therapy equipment portions of the filter holder or master cone have been found to cast shadows in the field. Figure 5 shows an example in which the metal fittings of an ionization chamber placed in the master cone have projected within the beam and appreciably reduced the area of field.

In agreement with the experience of Jacobson and of Silverstone and Wolf, a surprisingly large number of diaphragmed cones have shown on photographic examination that the beam does not coincide with the area defined by the face of the cone. In general, this has been due to faulty construction or assembly of the components of the cone, and it appears that a thorough testing of all cones is not carried out before delivery. Fortunately, these errors are usually easy to correct. The most frequent causes of lack of coincidence of the beam with the area of the cone face are lack of parallelism of the side of the diaphragm (for a rectangular port) with the side of the face of the cone, and the lateral translation of the central point of the cone face relative to the central point of the diaphragm aperture.

Photographic examination of the fields produced by cones is actually justified by the number of times in which unsuspected leakage of radiation through badly designed cones is detected. Figure 6 shows an example of such leakage, which has been found in all cones of the one type tested. This cone was intended to give a small circular field. The intensity of the radiation leakage was sufficient to cause definite skin damage in a prolonged treatment. It will be noticed that the 7 × 5-inch film used in the photograph of Figure 6 was not large enough to show the complete ring of leakage radiation. In the case of the first cone of this type examined, the initial examination of the field was carried out with a film just large enough to record the main beam, and the leakage radiation was not detected until later, when the reason for the epilation of a patient in an area some distance from the lesion treated was being investigated.

### VARIATION OF FREE AIR OUTPUT WITH AREA OF CONE

Although with cones of the side-shielded type some variation of x-ray output may be obtained with area of field, in general this does not occur with cones of the top-diaphragm type. A recently installed therapy equipment was fitted with a type of master cone containing two sets of adjustable lead diaphragms at right angles to each other, so that an infinite number of rectangular treatment ports could be obtained. Measurements of the x-ray output showed no variation greater than the experimental error for fields with areas ranging from 18 to 625 sq. cm. Table II sets out a number of these free air outputs for various areas of field. The individual values were derived from one measurement of the time required to deliver 20 r using a calibrated Hammer dosimeter. Where a slightly discrepant value was obtained, it was recorded, and thus possible errors in individual readings due to variation in supply voltage, tube current, etc., occur in the values shown. The readings for the circular fields were made by inserting a number of circular apertures below the master cone when the adjustable diaphragms were wide open. With areas smaller than 18 sq. cm., some decrease in the free air dose was found. This result is

TABLE II: UNIFORMITY OF FREE AIR OUTPUT WITH AREA OF FIELD

| Field in cm. | Free Air Output r/min. |
|---|---|
| 4.8 circle | 22.8 |
| 6.0 circle | 23.2 |
| 7.5 × 7.5 | 22.7 |
| 5 × 12.5 | 22.7 |
| 9.0 circle | 23.2 |
| 5 × 15 | 22.8 |
| 18 × 5 | 22.7 |
| 11.0 circle | 23.4 |
| 10 × 10 | 23.4 |
| 15 × 15 | 23.4 |
| 20 × 20 | 23.2 |
| 25 × 25 | 22.8 |
| Mean 23.0 ± 1.2 per cent | |

in agreement with those obtained with cones of fixed area.

The decrease in output with cones of small area may be due to two causes: (1) The focal spot may not be situated centrally with respect to the aperture in the tube wall. (2) The cone diaphragm may not be situated centrally with respect to this aperture. In either case, the decrease becomes greater the smaller the area of the cone, or the larger the focal spot of the tube. For this reason, the use of very small cones (with a field of diameter 1 cm.) with tubes with a focal spot of approximately the same diameter invariably leads to a greatly decreased output and nonuniform irradiation over the field. Even with cones of larger area, errors due to either of the above causes will introduce an appreciable variation of intensity over the area of the field.

It is now a routine procedure during the initial calibration of any tube by this laboratory to check the centering of the focal spot, and of the cone mounting, with a pin-hole camera. The camera consists of a rigid steel framework, carrying on a platform at the lower end a film holder in contact with which fine wires are stretched to produce fiducial lines on the film. The pin hole is carried on an intermediate platform, while to the upper platform can be attached the appropriate adaptors so that the camera can be mounted on any type of tube housing in place of the treatment cone. During the exposure, there is sufficient off-focus radiation to register the cross wires clearly on the film. Two

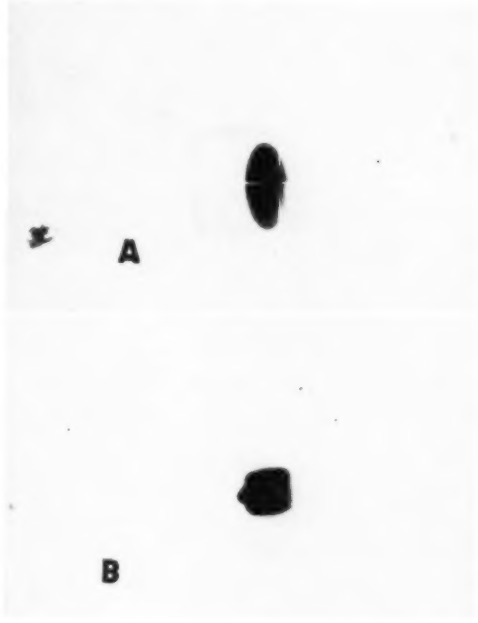


Fig. 7. Pin-hole camera photographs showing displacement of the focal spot from the geometrical center of the x-ray tube. A truly centered focal spot would lie on the single reference line equidistant from the double reference lines. A. Focal spot displaced along tube axis. B. Focal spot displaced at right angles to tube axis.

separate pin-hole photographs are taken, the cone adaptor being reversed on the tube mounting for the second exposure. If the image of the focal spot occupies an identical position on each film, then the cone mounting is correctly centered and aligned, while lack of centering of the focal spot is determined by the image falling away from the center of the cross wires. Two typical pin-hole photographs are shown in Figure 7. It is our experience that the focal spot is usually correctly centered in the tube axis, but may be displaced along the axis. In some cases this displacement has been due to the position in which the tube is located in the tube housing. We have not found any tube to show such large departures from centering as were found by Jacobson. Even small displacements can, however, seriously affect the distribution through cones of small area; for example, with one equipment having a tube with focal spot 10 mm.

TABLE III: VARIATION OF FREE AIR OUTPUT WITH CONES OF SMALL AREA

| Treatment Cone Diameter in cm. | Free Air Output r/min. |
|---|---|
| 2.0 | 18.0 |
| 2.5 | 21.1 |
| 3.0 | 22.5 |
| Open port | 22.5 |

in diameter displaced 7 mm. from the axis of the cone, the free air outputs shown in Table III were obtained with different cones.

Photographic examination of the field given by the 2-cm. cone showed a wide variation in intensity over the area, as would be expected when a portion of the focal spot lay outside the cone of radiation selected by the diaphragm. To avoid this difficulty, we do not recommend the use of small diameter cones, but prefer to use a larger diameter cone (from 3 to 5 cm. depending upon the size of the focal spot) and to limit the beam to the desired area by a lead screen with a suitable aperture attached to the skin with adhesive tape. It should be emphasized that the use of small cones has another disadvantage in that it is more difficult to ensure that the beam covers the desired area, both at the commencement of treatment and during the exposure, when slight involuntary movement of the patient may seriously disturb the alignment.

### GENERAL SHAPE OF COMPRESSION CONES

In many cases, the shape of compression cones is not satisfactory. Treatment cones with parallel sides are more readily introduced into body angles (such as the neck) than those which converge from the maximum area of the master cone. The painting of lines on the walls of treatment cones to mark the direction of the central and extreme rays is an advantage in assisting in correct alignment. The exit surface of many cones is a plane at right angles to the central ray and forms sharp edges at the intersections with the walls. These edges cause discomfort and seriously limit the degree of compression which can be applied, particularly in anatomical sites adjacent to bony points. All cone faces should be gently rounded, and the edges finished in a smooth curve. A compression cone molded from a transparent plastic would have many advantages.

### INTRACAVITY TYPE CONES

In some cases intracavity type cones are supplied with high-voltage equipment in an attempt to provide technics similar to those of Chaoul and of Schaeffer-Witte. In general, these cones are not particularly satisfactory from the physical point of view. In one example, a lead-lined converging cone rigidly attached to the tube housing is used with a variety of metal intra-oral specula and hard rubber intravaginal specula. In practice, the converging cone simply bears against the end of the speculum, free relative movement being possible. The fields of these applicators have been examined photographically and it was shown that a lack of alignment of less than 5 degrees (an inclination which is often undetected by untrained personnel) between the axes of the cone and the speculum results in an appreciable portion of the exit area of the speculum being completely shielded from radiation (see Figure 8). Even if the cone were correctly set up initially, a movement of this amount could easily be undetected during a treatment. In any case, the converging nature of both the cone and the speculum results in a side-shielded cone with a considerable proportion of scattered radiation which makes any accurate determination of skin and depth dose extremely difficult.

With the hard rubber intravaginal specula, a further difficulty is introduced due to the leakage of radiation. Although each speculum is provided with a detachable "x-ray protective ring," it is evident from Figure 9 that a very appreciable quantity of radiation is delivered outside the exit area of the speculum. The fact that this leakage traverses the surface of the vagina is an additional disadvantage.

Our experience with cones of these types leads to the conviction that they should be carefully examined from the physical point of view before use is made of them.

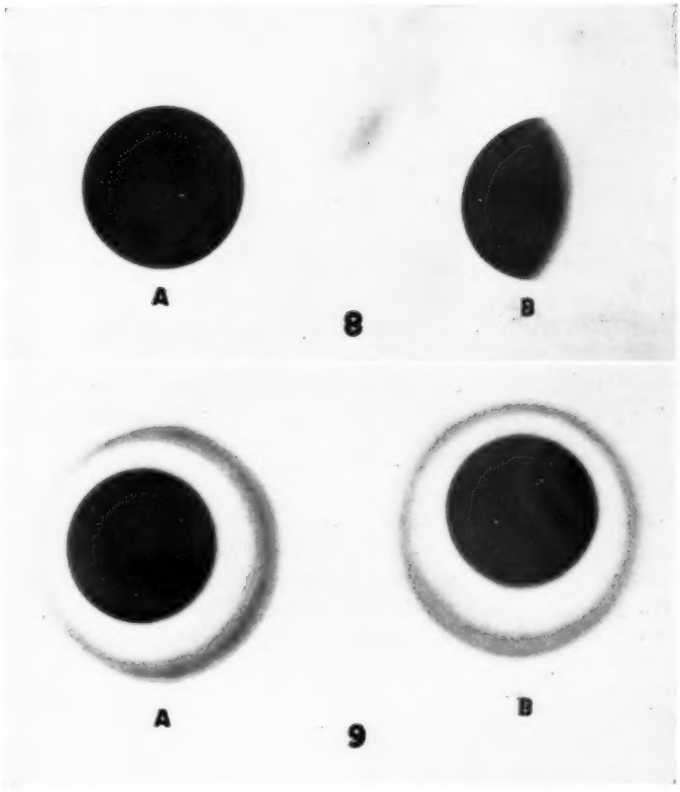


Fig. 8. Fields produced with intra-oral specula (A) correctly aligned, and (B) out of alignment by 5 degrees.

Fig. 9. Fields produced with hard rubber intravaginal specula (A) without and (B) with "x-ray protective ring."


## SUMMARY

As a result of experience with different types of treatment cones, it is believed that many of them suffer from serious disadvantages from a physical point of view. It is suggested that careful attention to physical requirements would lead to the introduction of cones which would be more satisfactory in practical application.

It is claimed that treatment cones in which the field is defined by an aperture at the top of the cone are more satisfactory than those which define the field by means of radiopaque walls.

The desirability of photographically examining the field produced by each cone is emphasized, and examples are given of typical defects which have been detected.

It is shown that the field produced by extremely small cones is often non-uniform and has a lower dosage than would be expected and that the extent of this depends upon the dimensions of the focal spot and upon the lack of accurate centering of the focal spot with respect to the cone axis.


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# EDITORIAL

## The Latent Period Which Elapses Between the Onset of a Lesion and the Appearance of Radiographic Signs

A comparative macroscopic and radiographic study of such structures as the lungs or bones, the details of which appear to be so entire in the radiograph, readily reveals to the competent observer the fact that lesions need to have attained a sufficient size or have led to sufficient change before they will produce a contrast density which permits of their detection on the radiograph. Large lesions may be present, yet the radiograph will not reveal them. Obviously, considerable histologic change may occur before any macroscopic alteration is detected. In tissues other than bones and lungs, where the pathological changes produce no material increase in density, we are entirely dependent upon evidence of deformity of such contours of the affected or adjacent tissues as can be demonstrated by radiology. It should not be astonishing, therefore, to realise that it takes time for radiographic signs to become recognisable after the onset of any assault, whether it be on the patient or on the pathologic process by medicaments, etc.

The latent period in association with infectious diseases, *i.e.*, that period which elapses between infection and the appearance of clinical signs, is well recognised, but it is not appreciated as much as it should be that, while the clinical signs in the early stages of disease or following an injury may be very prominent, the radiograph may still fail to reveal any abnormality at the site. Perhaps even less is it recognised that, after the initial clinical signs have faded, radiographic evidence may still be absent or so insignificant that it may be missed by any but the experienced observer, and that, when radiographic signs are well marked, the clinical signs may be insignificant. In other words, the radiographic signs lag behind the clinical at the onset, throughout the duration, and during resolution.

The duration of this lag shows considerable variation in different conditions. In some, as pneumonia, it is short; in others, as cysticercosis, it may be five or ten years. While we must, therefore, think of a negative latent radiographic period following onset, we must think also of that positive radiographic period which exists after the disappearance of clinical signs. In some conditions positive radiographic evidence persists throughout the remainder of an apparently healthy life.

Obviously, radiographs during the latent radiographic period will reveal no evidence of the disease, though it may be present. Further radiographs must be taken after an interval depending on the condition, if we wish to obtain confirmatory evidence. The interval between the first negative radiograph and the request for the second, which shows positive signs, is usually much longer than the latent radiographic period—probably because the first radiograph was of a patient with prominent symptoms which have shown some abatement in the interval, a second being called for only because of a recrudescence of symptoms or their failure to clear within a reasonable time. In the case of the latent period at the onset of a recurrence, we may have an additional difficulty, *i.e.*, residual radiographic evidence of healed disease but no indication of reactivity.

Failure to appreciate the discrepancy be-

tween clinical and radiographic signs has often had an unfortunate bearing on the treatment of the patient. A few instances may be given from the many which occur. Following trauma to a bone or dislocation of a joint, the radiographic signs of damage may not be detected for weeks, months, or even a year or so, during which time the initial signs and symptoms may have gone and the unfortunate patient may be encouraged or even compelled to use—and destroy—the limb or joint. In such cases the surgeons are liable to blame for these disasters in so far as they deliberately failed to seek the co-operation of their radiological colleagues. Radiographic evidence of osteomyelitis does not appear for ten days or more after the onset of prominent clinical signs. To wait for it would be disastrous. In malignant disease of any deep organ and in malignant metastases in bone, clinical signs or symptoms may be present for months or a year or more before there is radiographic evidence. Carcinoma of the rectum may not only produce prominent clinical signs and symptoms but may even be detected by digital examination at a time when a thorough radiographic examination is negative. One has to think merely of the lack of radiographic evidence in the first two months of normal pregnancy to realise how large a lesion and how prominent the physical signs can be without any radiological evidence. It has been shown that in the case of pregnancy with foetal osteogenesis imperfecta the foetal skeleton may not be recognisable even at full term. Until recently, cerebral tumours could grow to a great size without producing any radiographic evidence and, even with the aid of contrast media, the negative latent radiographic period may be long.

In the case of such a condition as tuberculosis, where there is a tendency to assign prime importance to radiographic evidence for detection of the lesions and isolation of the patient, the negative latent radiographic period at the onset of the disease in the bones and the lungs, the persistence of the radiographic evidence when all the clinical signs have gone, and the delay between the recurrence of symptoms and the appearance of new radiographic evidence in addition to that which indicates healed disease, all call for very serious consideration. The clinical signs of tuberculosis of the bones and joints may be prominent for months or even a year or more before any confirmatory evidence can be obtained radiographically. Unfortunately, the negative radiographic evidence at onset of the primary lesion or the reactivation is apt to be relied upon as conclusive evidence of freedom from the disease, and no further request is made until months later, when the worsening of the patient's condition demands it, and then frequently the evidence of extensive disease is only too apparent. From the point of view of preventive medicine, this is particularly unfortunate, for such a patient can unknowingly infect others.

There is an exception which proves the rule that radiographic signs lag behind the clinical, *i.e.*, tumour metastases, hydatid cysts, and certain other conditions of the lungs may produce no local or systemic signs until they have reached a very considerable size, while their detection by radiography is possible long before clinical evidence appears. We radiologists have in the past emphasised and demonstrated what the radiograph will show and we have taught the clinician to expect confirmatory radiographic evidence particularly in cases with prominent clinical signs. We and our colleagues have illustrated our articles and lectures to students with radiographs having characteristic spectacular appearances, but we have said far too little about the many conditions which the radiograph will not show. Consequently, there is a tendency for our colleagues to regard the radiologist as incompetent and the radiograph as poor if it fails to furnish confirmatory evidence when clinical evidence is prominent.

JAMES F. BRAILSFORD, M.D.
*Birmingham, England*

### AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will resume its Annual Meetings in 1946 and has now definitely chosen Philadelphia as the place and May 13–17 as the time. Headquarters will be at the Philadelphia Municipal Auditorium, 34th Street below Spruce.

The Meeting will be conducted under the Presidency of Dr. Ernest E. Irons of Chicago and the General Chairmanship of Dr. George Morris Piersol of Philadelphia.

### JUBILEE ASSEMBLY

Under the above title, the Radiological Section of the Palestine Jewish Medical Association has published a collection of papers presented in observation of the tenth anniversary of its founding and the fiftieth of Roentgen's discovery of the x-ray.

The papers, which are printed in both Hebrew and English, include: Fifty Years of Roentgenology, by R. Link; Radiology and the American Jew, by I. Kaplan; The Development of Physics Since the Discovery of the X-Rays, by E. Alexander; The Significance of the Menopause for Mammary Carcinoma, by L. Halberstaedter and A. Hochman; The Roentgenological Pathology of Fractures, by L. Drey; The Tactics of Roentgen Examination of the Urinary Tract in Connection with Pyeloscopy, by H. Salinger and F. Saalberg; Fifty Years' Progress in X-Ray Photographic Materials, by H. S. Tasker. Appended is a glossary of Hebrew roentgenologic terms with their English equivalents.

The volume carries the dedication "To the scientists of all nations who sacrificed their lives for the advancement of roentgenological science and to the physicians and scientists of Israel and of the nations of the world who fell in their fight against the dread of Nazism."

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

CLINICAL ROENTGENOLOGY OF THE HEART. ANNALS OF ROENTGENOLOGY, VOL. XVIII. By JOHN B. SCHWEDEL, M.D., Associate Attending Physician, Medical Division, Adjunct Attending Physician, Department of Roentgenology, Montefiore Hospital, New York; Attending Electrocardiographer and Associate Visiting Physician in Medicine, Gouverneur Hospital, New York; Lieutenant Commander, M.C. (V)S., U.S.N.R. A volume of 380 pages, with 749 illustrations in 232 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York, 1946. Price $12.00.

## Book Reviews

DR. W. C. RÖNTGEN. By OTTO GLASSER, Cleveland Clinic Foundation. A volume of 169 pages, with numerous illustrations. Published by Charles C Thomas, Springfield, Ill., 1945. Price $4.50.

Otto Glasser, who has established his reputation as Röntgen's biographer by his earlier accounts of the life of the great physicist in both German and English, has prepared a new volume in honor of the one-hundredth anniversary of Röntgen's birth and the fiftieth anniversary of his discovery of "a new kind of rays." The book is sponsored jointly by the American Roentgen Ray Society, the Radiological Society of North America, and the American College of Radiology.

It is a small volume of 169 pages, printed on good paper and in an attractive format, though one could wish that a somewhat better binding had been used. Much of the material was included in the author's previous life of Röntgen but enough that is new has been added to furnish an interesting supplement to the earlier work.

The material covers the main events of Röntgen's life, with special emphasis on the period of his epochal discovery and the ensuing years. The style is simple and graceful and Röntgen's home life and his scientific pursuits are presented with unusual vividness. One almost shares his suprise as on that memorable Nov. 8 he lighted a match and "discovered that the source of the mysterious light was the little barium platinocyanide screen lying on the bench." New translations of the three communications in which the discoverer accurately describes the rays and their physical characteristics are included and a bibliography of all Röntgen's scientific papers as well as a chronology of his life are appended.

The 1945 YEAR BOOK OF RADIOLOGY. Diagnosis, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor, WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital (on leave with the Armed Forces). Therapeutics, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 464 pages,

with 342 illustrations. Published by The Year Book Publishers, Inc., Chicago, Ill. Price $5.00.

The 1945 "Year Book of Radiology" is the fourteenth of this series of volumes, bringing together in digest form not only the significant contributions to the radiological literature for the past year but assembling, also, scattered articles of radiologic interest from a large number of clinical journals. The abstracts are carefully prepared and many illustrations from the original papers are reproduced. It is gratifying to find *Acta Radiologica* once again well represented.

In making up the volume, the illustrations have been placed in closer juxtaposition to the text with which they belong than in some of the earlier Year Books. This is of distinct advantage, but still further improvement could be made by printing beneath each cut the original reference with the name of the author and the journal from which the abstract was prepared. Not only would this be of aid to the reader but it would give well deserved credit to the many journals from which the material is drawn.

Like its predecessors, the book is divided into two sections—on diagnosis and therapy. Both are arranged in general on an anatomical basis. The therapy section is prefaced by a useful introduction furnishing a general survey of the field and includes also sections on Radiation Biology and Radiation Physics.

The book is well printed and attractively bound in the general style of the earlier volumes. A useful index is included. This series of books is of increasing value for quick reference to individual subjects and for its comprehensive summary of the current literature.

KETTLE'S PATHOLOGY OF TUMORS. Edited by W. G. BARNARD AND A. H. T. ROBB-SMITH. A volume of 318 pages. Third Edition. H. K. Lewis and Co., Ltd., London, 1945. Price 21 shillings.

There are few medium-sized books in English which are devoted solely to the discussion of the gross and microscopic essentials of the morphology of tumors, while the few good French and German texts are inaccessible to most students, owing to the barrier of language. Kettle's small volume, originally appearing in 1916, was the first compact treatise in English to contain sufficient information for the interne or hospital resident. The author had considerable skill in drawing and prepared many of the excellent illustrations in the first edition, which numbered 224 pages. This third edition contains 318 pages and 65 additional cuts, most of which are photomicrographs.

The new editors are amply equipped for their task, as a cursory survey of the text will show. The most important expansion has taken place in the consideration of tumors of the nervous system. No valuable space has been wasted in useless theoretic discussions or in descriptions of those extremely rare tumors which are met with only a few times in the ordinary physician's professional life. These are dismissed, as a rule, with a short note and references to sources where fuller details can be obtained. A short but sufficiently complete section is devoted to a survey of the experimental study of cancer, and the essential facts as regards the etiology of the disease are covered in twelve pages.

The reproduction of Kettle's drawings and of the new photographic cuts is excellent. The reviewer's only criticism is that the magnification of the drawings is expressed in the Teutonic style, by giving the focal length of the objective and the number of the ocular. As the focal length of the objective is not always as stated by the manufacturer, and eyepieces of the same number vary considerably, it would be better if the magnifications were expressed in the proper fashion, that is, in actual diameters. In comparing pictures with a section for diagnosis, it is sometimes helpful to know the magnification. Also, a certain number of the otherwise excellent composite cuts have been reversed, presumably by the printer, so that the legends do not correctly indicate the areas described.

The writer knows of no more convenient and competent short treatise on tumors than this revision of Kettle by Barnard and Robb-Smith. It should be widely used. The price in England is $4.25, but this country, while talking loudly on the advantages of research, proceeds to tax it by still retaining the astounding practice of imposing an import duty on books printed in English.

PHYSICAL CHEMISTRY OF CELLS AND TISSUES. By RUDOLF HÖBER, University of Pennsylvania School of Medicine, Philadelphia. With the collaboration of DAVID I. HITCHCOCK, Yale University School of Medicine, Laboratory of Physiology, New Haven, Conn., J. B. BATEMAN, Mayo Clinic, Rochester, Minn., DAVID R. GODDARD, University of Rochester, Biological Laboratories, Rochester, N. Y., and WALLACE O. FENN, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y. A volume of 676 pages, with 70 illustrations. Published by The Blakiston Company, Philadelphia. Price $9.00.

"Physical Chemistry of Cells and Tissues" by Rudolf Höber will, as the title indicates, be of greatest interest to those engaged in research in biophysics, physiology, and biochemistry, the more so as the writers have assumed a considerable knowledge of mathematics and physical chemistry on the part of their readers.

The first section of the book, by David I. Hitchcock of Yale, deals in a systematic manner with laws and principles of physical chemistry and their appli-

cation to biological phenomena. In this way the author promotes the same cause as does the experimental biologist who takes biological phenomena as his central interest, and searches in physics and chemistry for possible explanations. The second section, by Bateman, of the Mayo Clinic, reflects the present-day interest in large molecules and deals with their properties and functions. Advances in knowledge of the structure of such substances as cellulose, starch, glycogen, proteins, and other high polymers have been due largely to x-ray methods of analysis and other physical procedures.

Sections 3, 4, 5, and 8, by Höber, deal with the structure of protoplasm, permeability, the influence of various ions and narcotics on cell activity, and with processes such as absorption from the intestine, formation of digestive secretions, and secretion of urine. The approach to these problems is, as would be expected, largely physicochemical.

In Section 6, Goddard, of the University of Rochester, deals with the nature of respiration and oxidation and with the mechanism of these processes, that is, with some of the more important enzymes, coenzymes, and substrates involved in respiration and oxidation. By far the greater part of Section 7, contributed by Fenn, also from the University of Rochester, is devoted to the subject of contractility in muscle, but evidence that ciliary motion, ameboid movement, and protoplasmic streaming are related phenomena is also reviewed. The structure of muscle, mechanics of contraction and attendant chemical changes, and the theories of muscle contraction are discussed in detail.

CLASSIC DESCRIPTIONS OF DISEASE, WITH BIOGRAPHICAL SKETCHES OF THE AUTHORS. By RALPH H. MAJOR, M.D., Professor of Medicine, University of Kansas School of Medicine. A volume of 679 pages, with 158 illustrations. Published by Charles C Thomas, Springfield, Ill. Third edition, 1945. Price $6.50.

Major's "Classic Descriptions of Disease" fills two important needs for the medical student. It introduces him to the history of medicine, and it fixes in his mind the clinical features of some of the most important diseases. After reading it he will write better clinical histories.

The brief biographical sketches that precede the descriptions of diseases are well done. The descriptions themselves are carefully chosen and accurately translated. The book is attractively printed and well illustrated.

In this, the third edition, a few new descriptions of disease have been added. Among these, Louis' description of typhoid fever and accounts of the cardiac lesions in endocarditis by Riverius, Morgagni, Bouillaud, Virchow, and Winge, are the most important.

It is to be hoped that when another edition of this useful book is published, the author will include descriptions of some of the more important surgical diseases. Peptic ulcer, gallbladder disease, and appendicitis are the only lesions of this general class now dealt with. A well rounded choice would include descriptions of a number of the more frequent surgical diseases, such as carcinoma of the breast, osteomyelitis, and tuberculosis of cervical lymph nodes. For the beginning medical student, who should read Major's book as an introduction to clinical work, these surgical diseases are more important than some of the less common medical conditions, as sickle-cell anemia and angioneurotic edema, now included in the book.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

## UNITED STATES

*Radiological Society of North America.—Secretary,* D. S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N.Y.

*American Roentgen Ray Society.—Secretary,* Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.—Secretary,* Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

*Section on Radiology, American Medical Association.—Secretary,* U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

### ARKANSAS

*Arkansas Radiological Society.—Secretary,* J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

### CALIFORNIA

*California Medical Association, Section on Radiology.—Secretary,* Gordon King, M.D., Children's Hospital, San Francisco.

*Los Angeles County Medical Association, Radiological Section.—Secretary,* Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.—Acting Secretary,* Frederick H. Rodenbaugh, M.D., 490 Post St., San Francisco. Meets annually with California Medical Association.

*San Diego Roentgen Society.—Secretary,* Henry L. Jaffe, M.D., U. S. Naval Hospital, San Diego, Calif. Meets first Wednesday of each month.

*San Francisco Radiological Society.—Secretary,* Joseph Levitin, M.D., 516 Sutter St., San Francisco 2. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

### COLORADO

*Denver Radiological Club.—Secretary,* A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month, Denver Athletic Club.

### CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.—Secretary,* Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

### FLORIDA

*Florida Radiological Society.—Secretary-Treasurer,* J. F. Pitman, M.D., Blanche Hotel Annex, Lake City.

### GEORGIA

*Georgia Radiological Society.—Secretary-Treasurer,* James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meets in November and at the annual meeting of State Medical Association.

### ILLINOIS

*Chicago Roentgen Society.—Secretary,* Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.—Secretary-Treasurer,* William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.—Secretary,* Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

### INDIANA

*The Indiana Roentgen Society.—Secretary-Treasurer,* Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

### IOWA

*The Iowa X-ray Club.—Secretary,* Arthur W. Erskine, M.D., Suite 326 Higley Building, Cedar Rapids. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

### KENTUCKY

*Kentucky Radiological Society.—Secretary-Treasurer,* Sydney E. Johnson, M.D., 101 W. Chestnut St., Louisville.

### LOUISIANA

*Louisiana Radiological Society.—Secretary-Treasurer,* Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.—Secretary,* Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

### MARYLAND

*Baltimore City Medical Society, Radiological Section.—Secretary,* Charles N. Davidson, M.D., 101 West Read St., Baltimore 1.

### MICHIGAN

*Detroit X-ray and Radium Society.—Secretary-Treasurer,* E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

*Michigan Association of Roentgenologists.—Secretary,* Bruce MacDuff, M.D., 201 Sherman Bldg., Flint 3.

### MINNESOTA

*Minnesota Radiological Society.—Secretary,* A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

### MISSOURI

*Radiological Society of Greater Kansas City.—Secretary,* John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

*St. Louis Society of Radiologists.—Secretary,* Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September.

### NEBRASKA

*Nebraska Radiological Society.—Secretary-Treasurer,* Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

### NEW ENGLAND

*New England Roentgen Ray Society.—Secretary-Treasurer,* George Levene, M.D., Massachusetts Memorial Hos-

pitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

### NEW HAMPSHIRE

*New Hampshire Roentgen Society.—Secretary-Treasurer,* Richard C. Batt, M.D., St. Louis Hospital, Berlin.

### NEW JERSEY

*Radiological Society of New Jersey.—Secretary,* H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

### NEW YORK

*Associated Radiologists of New York, Inc.—Secretary,* William J. Francis, M.D., East Rockaway, L. I.

*Brooklyn Roentgen Ray Society.—Secretary-Treasurer,* Leo A. Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.—Secretary-Treasurer,* Joseph S. Gian Franceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Society.—Secretary-Treasurer,* Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings in January, May, and October.

*Long Island Radiological Society.—Secretary,* Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.—Secretary,* Wm. Snow, M.D., 941 Park Ave., New York 28.

*Rochester Roentgen-Ray Society.—Secretary,* Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

### NORTH CAROLINA

*Radiological Society of North Carolina.—Secretary-Treasurer,* Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meets in May, and October.

### NORTH DAKOTA

*North Dakota Radiological Society.—Secretary,* Charles Heilman, M.D., 1338 Second St., N., Fargo.

### OHIO

*Ohio Radiological Society.—Secretary,* Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.—Secretary-Treasurer,* Carroll C. Dundon, M.D., 2065 Adelbert Road, Cleveland 6. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine* (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

### PENNSYLVANIA

*Pennsylvania Radiological Society.—Secretary-Treasurer,* L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

*Philadelphia Roentgen Ray Society.—Secretary,* Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

*Pittsburgh Roentgen Society.—Secretary-Treasurer,* Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24. Meets second Wednesday of each month at 6:30 P.M., October to May, inclusive, at The Ruskin, 120 Ruskin Ave.

### ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

### SOUTH CAROLINA

*South Carolina X-ray Society.—Secretary-Treasurer* Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 1.

### TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.—Secretary-Treasurer,* J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

### TEXAS

*Dallas-Fort Worth Roentgen Study Club.—Secretary,* R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth, 4. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

*Texas Radiological Society.—Secretary-Treasurer,* Asa E. Seeds, M.D., Baylor Hospital, Dallas.

### VIRGINIA

*Virginia Radiological Society.—Secretary,* E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

### WASHINGTON

*Washington State Radiological Society.—Secretary-Treasurer,* Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

### WISCONSIN

*Milwaukee Roentgen Ray Society.—Secretary-Treasurer,* C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.—Secretary,* S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society in September.

*University of Wisconsin Radiological Conference.*—Meets first and third Thursdays, 4 to 5 P.M., September to May, inclusive, Room 301, Service Memorial Institute, 426 N. Charter St., Madison 6.

## CANADA

*Canadian Association of Radiologists.—Honorary Secretary-Treasurer,* J. W. McKay, M.D., 1620 Cedar Ave., Montreal.

*La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary,* Origène Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meets monthly.

# ABSTRACTS OF CURRENT LITERATURE

## ROENTGEN DIAGNOSIS

### The Head and Neck



### The Chest



### The Digestive System



### Abdominal Injuries



### The Musculoskeletal System

**Gynecology and Obstetrics**



**The Genito-Urinary Tract**



**The Blood Vessels**



**Gas Gangrene**



**Technic**



## RADIOTHERAPY

**Neoplastic Disease**



**Non-Neoplastic Disease**



**Technic and Dosage**



**Effects of Radiation**

# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Value of Routine Roentgenographic Studies of War Injuries of the Head and Neck.** Gilbert N. Haffly. Arch. Otolaryng. **41:** 216–217, March 1945.

A case is presented which dramatically illustrates the value of routine roentgen studies of all war wounds in which a retained radiopaque foreign body might be suspected. A soldier in the South Pacific area was wounded in the left orbital region by a fragment of an artillery shell. The left globe was enucleated, and a large ragged laceration of the lower left eyelid and adjacent region of the cheek was repaired with linen sutures within three hours after injury at a nearby evacuation hospital. No roentgenographic studies were considered necessary. Five days later, at another hospital, the patient was free of complaints except for tenderness in the region of the left orbital wound, which had become secondarily infected. Roentgen studies now revealed a large metallic fragment wholly within the cavity of the left maxillary sinus. The foreign body was removed, and the wound healed primarily, without evidence of sinus infection.

**Skull Defect and Herniation of Cerebrum with Absence of Dura Following Head Injury in Adolescence.** Wm. S. McCune and Barnes Woodhall. Arch. Neurol. & Psychiat. **53:** 307–308, April 1945.

The authors describe an unusual instance of a defect in the inner table of the skull with absence of the dura and associated herniation of the brain following head injury (operative confirmation). Investigation of recurrent episodes of loss of consciousness led to discovery of an irregular defect in the calvarium at the site of a head injury sustained some seventeen years previously. Significant roentgen findings consisted of an area of "moth-eaten" destruction involving the inner table of the left parietal bone over which tenderness could be elicited on pressure. Pneumoencephalographic studies showed slight dilatation and upward displacement of the posterior half of the body of the left lateral ventricle. Deviation of the ventricle toward the defect suggested cortical atrophy in this region. This is an example of a degenerative process in the cranium following skull fracture during adolescence, unusual in the destruction of the inner table, herniation of the brain into the defect, and absence of the dura. No attempt is made to explain the pathogenesis of the dural defect. This case is offered as an aid in the differential diagnosis of destructive lesions of the calvarium.

GUERDON GREENWAY, M.D.
(University of Michigan)

**Displacement of Pineal Gland with Extradural Hemorrhage.** M. J. Madonick and Ignaz W. Oljenick. Arch. Neurol. & Psychiat. **53:** 311–312, April 1945.

The authors present a case of shift of a partially calcified pineal gland resulting from extradural hemorrhage following traumatic rupture of the middle meningeal artery. Attention is called to the fact that the available literature dealing with roentgen findings in the skull in cases of extradural hemorrhage is chiefly concerned with the presence or absence of a fracture line crossing the groove of the middle meningeal vessels, little or no emphasis being placed on the associated shift of the pineal. The authors feel that a relatively large effusion of blood must be present to produce such a shift.

GUERDON GREENWAY, M.D.
(University of Michigan)

**Aerosinusitis.** R. Wesley Wright and Harold M. E. Boyd. Arch. Otolaryng. **41:** 193–203, March 1945.

Aerosinusitis is an acute or chronic sinus inflammation caused by trauma to the mucous membrane as a result of a difference between the air pressure within the sinus and that of the surrounding atmosphere. This phenomenon occurs commonly during changes in altitude in airplane flights and is accompanied by pain and discomfort. The pain is acute, localized to one of the sinus areas, more commonly in the frontal region. As the pain subsides after equalization of pressure, it may be replaced by a sense of stuffiness. The patient may blow blood from the nasal passages of the affected side, or blood may appear in the nasopharynx and the sputum. In all cases the aerosinusitis and accompanying symptoms are directly proportional to the rapidity of the change in pressure on ascent or, more commonly, on descent.

Reports of roentgen examinations in cases of aerosinusitis frequently direct attention to a haziness of many sinuses or an opacity of one or both antra with clouding of other sinuses. At times roentgenography is the only means of detecting the condition, but inability to focus roentgenographically on any one sinus as the site of a pathologic process makes statistical analysis nearly impossible. Occasionally abnormalities are discovered, such as a septal deviation or a pathologic change in the antra. Either or both could be the causative condition.

Immediate treatment consists in an attempt to equalize the differential pressure within and without the sinus. Leveling off and ascent in the low-pressure chamber are standard procedures when it is necessary to secure relief from sinus pains. If, as is usually true, the condition is due to decreased pressure within the sinus with an increasing pressure without, as occurs on descent, ascent will bring the affected sinus to a level where the trapped air will be of the same density as the outside air. There will then exist no differential, and the sinus duct or ostium may open easily, with relief of symptoms. Nasal shrinkage is then used to assure a patent opening. The treatment of a well developed condition varies with the severity of the symptoms. Usually the pain in the sinus or the headache disappears in a short time and no treatment is necessary other than that for a pre-existing sinusitis. Hemorrhages in the sinus mucosa are usually absorbed unless they are too extensive.

Roentgenograms are reproduced.

## THE CHEST

**Acute Putrid Abscess of the Lung.** Harold Neuhof. Surg., Gynec. & Obst. **80:** 351–354, April 1945.

Operation has been done in 172 cases of acute putrid abscess of the lung in the past sixteen years at the Mount Sinai Hospital (New York) with 4 deaths.

All putrid pulmonary abscesses may be assumed to

result from aspiration of infected material. There is set up a gangrenous bronchopneumonia in the involved bronchopulmonary segment, with abscess formation occurring within two weeks. The abscess is always situated superficially within the pulmonary lobe and abuts on the parietal surface, almost always toward the thoracic parietes. The important feature from a surgical standpoint is the constant occurrence of pleural adhesions which seal off the free pleural space and make possible safe surgical entry. Abscesses of over six weeks duration are considered chronic and show complicating features which are less amenable to treatment.

The diagnosis of pulmonary abscess cannot always be made on the basis of the roentgen film alone, but localization is always possible and represents the essential basis for correct surgical management. The films show a cavity with fluid level in only about half the cases, and some cases show only a circumscribed area of dense infiltration, in which rarefaction may or may not subsequently develop. Exact localization is done by the "spot" method of Rabin. This depends upon injecting into the intercostal muscles a mixture of methylene blue and iodized oil at the spot where the abscess is assumed to abut on the thoracic wall. This spot is often determined fluoroscopically. After injection, films are taken in appropriate positions to show the relationship of the iodized oil to the abscess. The methylene blue serves as a guide to the surgeon at operation.

A one-stage operation is carried out on the basis that, if the localization is exact, sufficient adhesions to give adequate walling off are always encountered. A segment of one rib is resected, the abscess is unroofed, and the cavity packed with gauze. The fistula should not be permitted to close too soon but should be maintained by packing for four to eight weeks. The immediate improvement is striking and the late results have been satisfactory. The few recurrences are ascribed to either inadequate unroofing of the abscess or premature closure of the wound. J. L. BOYER, M.D.

**Primary Tuberculous Infection in a Sanatorium Staff. Investigation and Supervision.** Peter W. Edwards and A. Clark Penman, with **Radiological Interpretations** by L. G. Blair. Lancet **1:** 429–431, April 7, 1945.

The authors report the results of examination for tuberculosis in the Cheshire Joint Sanatorium (Market Drayton, England). The routine examination as applied to new members of the staff includes clinical examination, the Mantoux test, radiologic examination, and a blood sedimentation test. The Mantoux test is repeated monthly in negative cases and radiographic studies are made at intervals of three months until the test becomes positive. Further radiologic studies are spaced at the discretion of the physician. The uneventful case usually goes on to half-yearly examinations three months after the positive reaction. When a primary complex is demonstrable, roentgenography is repeated at intervals of three months. Blood sedimentation tests are carried out monthly until the Mantoux test is positive and are continued at monthly intervals for a minimum of three months. Thereafter they are repeated at each x-ray examination.

In a seven-year period, no cases of tuberculosis developed among the Mantoux-positive entrants, 170 in number. Of the 72 persons with a negative Mantoux test on admission to the staff, 21 left before the test became positive, 1 remained negative at the time of the report (46 months after joining the staff), and 50 became positive. Two of the 50 left without further examination. Radiologic evidence of one or both components of the primary complex was present in 15 of the 48 remaining cases. The authors consider this a relatively high percentage of positive x-ray findings and attribute it to the frequent repetition of roentgen examination. Some cases would undoubtedly have been missed had examination been made only at yearly intervals.

In 9 cases recovery from the primary infection was delayed or accompanied by clinical illness, but in none did progressive tuberculosis develop.

**Mechanical Paralysis of the Left Hemidiaphragm Complicating Collapse Therapy in Pulmonary Tuberculosis.** Oscar Feinsilver. Dis. of Chest **11:** 138–149, March–April 1945.

It has long been known that paralysis of the left phrenic nerve may be followed by gastro-intestinal symptoms, as nausea and anorexia, with consequent malnutrition and loss of weight. Having observed a similar syndrome following left-sided therapeutic pneumothorax, with the phrenic nerve intact, the author undertook fluoroscopic studies in the hope of explaining the phenomenon. These revealed a decreased diaphragmatic excursion, more marked on the side of the collapse, leading to the conclusion that the mobility of the diaphragm depends not only upon the contractility of its muscle fibers and an intact phrenic nerve, but also upon the level of intrathoracic pressure. As in cases of phrenic paralysis, the diminished mobility of the left diaphragm interferes with normal propulsion of the contents of the fundus of the stomach beneath and adaptability to its increased filling during the course of a meal. Anorexia, with its accompanying disturbances, results.

Such a condition may interfere seriously with rehabilitation of the tuberculous patient at a time when nutritional requirements are high to keep pace with increasing metabolic demands. Two cases illustrating this phase of the problem are presented, while a third shows the influence of the condition in the treatment of an active case.

The author designates the syndrome as "mechanical paralysis of the left hemidiaphragm." It may make necessary a reduction in the frequency of refills, a decrease in the degree of collapse, and occasionally early abandonment of pneumothorax to permit continued progress. HENRY K. TAYLOR, M.D.

**Report of a Case of Acute Interstitial Fibrosis of the Lungs.** Howard Eder, Clinton Van Zandt Hawn, and George Thorn. Bull. Johns Hopkins Hosp. **76:** 163–171, April 1945.

A case of acute diffuse interstitial fibrosis of the lungs, resembling the 4 cases reported by Hamman and Rich (Bull. Johns Hopkins Hosp. **74:** 177, 1944. Abst. in Radiology **43:** 405, 1944), is reported. As in those cases, the patient showed evidence of advanced pulmonary disease, with shortness of breath and cough as the presenting symptoms. Dyspnea was moderate at first but increased progressively in severity, with an associated rise in the respiratory rate and the development of extreme cyanosis. Administration of oxygen gave considerable relief. Despite the extensive fibrosis of

the lungs, physical examination yielded only minimal evidence of the disease. As in 2 of the 4 cases previously described, only scattered râles were heard on first examination. Later a pleural friction rub developed; this sign also appeared in 2 of the previous cases. Clubbing of the fingers was unique in the present case. The roentgen appearance of the lungs suggested miliary tuberculosis, as in 2 of the previous cases. The cardiac findings were those of chronic cor pulmonale, the heart was definitely enlarged, and there was a loud gallop rhythm. At no time was there evidence of cardiac decompensation. The total duration of the disease appears to have been about seventeen weeks, which is well within the range of four to twenty-four weeks of the earlier series.

The autopsy findings in the present case included many of the pathological peculiarities of the 4 cases reported by Hamman and Rich. Most outstanding was the marked diffuse interstitial proliferation of fibrous tissue, of a progressive character, throughout all lobes of both lungs. The formation of a hyaline membrane lining the alveoli was not conspicuous in this case, nor were there striking numbers of eosinophils in the interstitial connective tissue. The etiology of the underlying pulmonary disease remains obscure.

**Pitfalls in the Diagnosis of Atypical Pneumonia.** Walter L. Nalls. Dis. of Chest **11:** 130–136, March–April 1945.

In spite of the low mortality from atypical pneumonia, the disease is not to be taken lightly either from the point of view of the individual patient or that of the population as a whole. Of particular importance is its differentiation from other chest diseases. The author is not in agreement with the generally prevailing impression that such diagnosis is altogether a simple matter or that the x-ray picture is distinctive. Not only has he frequently found it impossible to make a differentiation between pneumococcus and atypical pneumonia on the basis of the roentgenogram alone, but in some instances this has been impossible even with all the other available data at hand. Response to therapy has sometimes made the distinction, but the use of sulfonamides in atypical pneumonia is not to be encouraged.

Confusion with tuberculosis is another pitfall, though usually the onset of symptoms is different and the lesions are predominantly in the lower rather than in the upper lobes. The importance of a brief period of observation before instituting active treatment for tuberculosis is of particular importance. In an occasional case small disseminated shadows may suggest a miliary tuberculosis. As these shadows increase in size, the picture may resemble that of metastatic carcinomatosis or one of the fungus diseases.

Confusion with primary carcinoma of the lung has been observed when the roentgenogram shows a persistent sharply localized area of atelectasis, and the author has seen one case in which a bronchiogenic carcinoma was diagnosed as atypical pneumonia.

Finally, it may well be impossible to differentiate primary atypical pneumonia from bronchiectasis during the acute stage. In this connection the author mentions the "pseudobronchiectasis" reported by Blades and Dugan (J. Thoracic Surg. **13:** 40, 1944. Abst. in Radiology **43:** 404, 1944) as following atypical pneumonia and points out that, in a case of suspected bronchiectasis after primary atypical pneumonia, it is well to allow a period of observation and repeat the bronchogram before deciding upon surgical treatment of the bronchiectasis. HENRY K. TAYLOR, M.D.

**Pneumococcic Pneumonia Resembling Primary Atypical Pneumonia.** E. Racker, S. P. Rose, and A. O. Tumen. Am. J. M. Sci. **209:** 496–502, April 1945.

In a large series of cases of pneumococcic pneumonia there are not infrequently seen features which are considered characteristic of primary atypical pneumonia. These are bilateral patchy infiltrations, failure to respond to chemotherapy within forty-eight hours, presence of cold agglutinins, relative bradycardia, spiking temperature, normal or low leukocyte counts, dry cough and scanty sputum, and frontal headache. The absence of a pathogen in the sputum does not exclude the possibility of a bacterial invader. If one accepts the main criteria of atypical pneumonia as patchy bronchopneumonic infiltration of the lungs and a failure to respond to chemotherapy, the incidence of atypical cases of pneumococcic pneumonia is about 20 per cent.

Although the pneumococcic pneumonia may have been superimposed on a primary atypical pneumonia, there has been a striking response in these patients to specific serum therapy and an increasing occurrence of sulfonamide-fast strains.

Since a differentiation between primary atypical pneumonia and atypical pneumococcic pneumonia is difficult on clinical grounds alone, a bacteriologic etiology must be ruled out carefully before denying the patient chemotherapy or specific serum treatment.

BENJAMIN COPLEMAN, M.D.

**Primary Atypical Pneumonia of Unknown Cause.** Robert C. Schmitz. Arch. Int. Med. **75:** 222–232, April 1945.

This paper is essentially a review of the literature on atypical pneumonia and carries a comprehensive bibliography.

**Ingestion of Kerosene Complicated by Pneumonia, Pneumothorax, Pneumopericardium, and Subcutaneous Emphysema.** Arnold F. Lavenstein. J. Pediat. **26:** 395–400, April 1945.

The author presents a case of pneumonia, pneumothorax, pneumopericardium, and subcutaneous emphysema following ingestion of kerosene. This is similar to a case reported by Scott (J. Pediat. **25:** 31, 1944. Abst. in Radiology **44:** 307, 1945).

**Benign Pneumoconiosis.** Eugene P. Pendergrass and Simon S. Leopold. J. A. M. A. **127:** 701–705, March 24, 1945.

Benign non-specific pneumoconiosis, as the name implies, is that condition in the lungs resulting from the inhalation of organic or inorganic dusts which, while they may be retained, are neither toxic, allergenic, nor pathogenic. Although they may be capable of producing an insignificant amount of reactive fibrosis, this never progresses to true nodulation. Unlike free silica and asbestos, these dusts produce no symptoms, no disability, and no predisposition to tuberculosis—only shadows on the roentgenogram. In this group are included baritosis, which has been seen in the baryta miners in Italy and in a few workers in Pennsylvania, and the siderosis of electric arc welders. In baritosis the lungs are studded with small sharply circumscribed nodules which in the experimental animal have been

found to be due to collections of mineral dust, with no evidence of fibrous tissue overgrowth. There are no associated respiratory symptoms. Various authors have described the roentgen appearance in electric arc welders as a "fine nodulation" and as "simulating prenodular fibrosis."

To this group of benign pneumoconioses the authors add 4 cases of siderosis in metal grinders. The roentgen findings were similar in all respects to those in electric arc welders. Silicosis was excluded in these cases.

It is impossible to differentiate the roentgen appearance of nodulation of silicosis or the pseudo-nodulation of benign pneumoconiosis from the shadows cast by many pulmonary diseases unassociated with the inhalation of dust. The diagnosis of the pulmonary lesions in such circumstances depends on the collaboration of the internist, the roentgenologist, and the laboratory technician. To differentiate between silicosis and benign pneumoconiosis one must have a detailed knowledge of the occupational history and environmental conditions of the worker and precise information regarding the nature, concentration, and particle size of the dust to which he is exposed.

Advanced silicosis is usually disabling and, when complicated by tuberculosis, it is fatal. Advanced asbestosis produces disability and ultimately may induce death from cardiac failure. Benign pneumoconiosis produces nothing but shadows on a roentgenogram. It is therefore of greatest importance to the worker, to labor, and to industry that these conditions be distinguished.

**Iron Oxide Dust and the Lungs of Silver Finishers.** A. I. G. McLaughlin, J. L. A. Grout, H. J. Barrie, and H. E. Harding. Lancet **1:** 337–341, March 17, 1945.

Three silver finishers or polishers who had been exposed to the dusts of iron oxide and silver were examined clinically and roentgenographically in 1936. One of these men, who had worked as a silver finisher for forty years, died in 1943, after an operation for gastric ulcer. The lungs of this man were studied histologically, and chemical estimations of iron oxide and silver content were made. A fourth silver finisher was examined in 1938.

Little or no physical disability appears to be caused by the presence of iron oxide dust in the lungs, though in one case there was emphysema. The first three men were requested to report for examination because of the nature of their work and not because of any complaint of ill health. All had slight coughs. The fourth man complained of gastric symptoms of fifteen years' duration but had no symptoms or signs pointing to a chest condition. A chest film was taken only because of a family history of pulmonary tuberculosis.

X-ray examination of the chest revealed stippled or reticulated shadows in each of the four cases, the picture resembling that found in welders, in hematite miners, and in other workers who inhale iron and iron oxide dust. In silver finishers and in welders the individual shadows appear to be related in size and distribution to the aggregates of iron oxide dust found in the peribronchial and periarterial lymph spaces. The density of the shadows is apparently proportional to the amount of iron oxide dust present and also the anatomic weight of iron. No fibrotic changes (either collagenous or reticular) are set up in the lungs by the inhaled dust, which consists mainly of pure iron oxide. In cases of silicosis, the x-ray shadows are in the main not attributable to the presence of opaque dust, but probably to the amount of fibrotic tissue and congestion present in the lungs.

In the interpretation of chest roentgenograms of workers in dusty occupations, consideration should be given both to the activity of the dusts in producing pathological changes and to the opacity of the dusts to x-rays.

The term "siderosis" was applied by Zenker in 1866 to what he regarded as a pathological condition of the lungs caused by long-continued inhalation of the dust of iron or iron oxide. This term carries with it an implication that iron or its oxides causes fibrosis of the lungs; the authors believe that a clear distinction should be made between siderosis and sidero-fibrosis.

**Observations on Pulmonary Disease in Graphite Workers.** Lasar Dunner. Brit. J. Radiol. **18:** 33–35, February 1945.

Five patients were observed with pulmonary changes after industrial exposure to *pure* graphite dust for, seventeen, eighteen, twenty, twenty-, and thirty-four years. The changes demonstrable roentgenologically were nodular and coalescent fibrosis, similar to silicosis. There were some alterations in percussion and auscultation, but the physical signs were not in proportion to the changes seen on x-ray examination. Symptoms were minimal, consisting of cough with sputum. No tuberculosis was found.

SYDNEY J. HAWLEY, M.D.

**Serial Roentgenograms of the Chest in Periarteritis Nodosa as an Aid to Diagnosis.** A. Elkeles. **With Notes on the Pathology of the Pulmonary Lesions.** L. E. Glynn. Brit. J. Radiol. **17:** 368–373, December 1944.

Because of the diversity and changing character of the signs and symptoms, only a few of the 400 cases of periarteritis nodosa reported in the literature have been diagnosed during life. The common signs are remittent fever, tachycardia, polyneuritis, polymyositis, albuminuria, cylindruria, asthma, bronchitis, and a leukocytosis of 15,000–20,000, often with a high percentage of eosinophils. Occasionally there are nodules in the skin up to 1 cm. in diameter. Hemorrhagic and urticarial lesions are sometimes present. Biopsy of the skin nodules will show the typical vascular lesions.

The most widely accepted etiologic theory attributes the disease to an extreme degree of vascular allergy.

Involvement of the lungs has been reported only rarely, and few x-ray examinations of the chest are therefore recorded. The radiological signs may, however, be pronounced, even though the physical signs are slight, and serial examinations especially may be of diagnostic value. The signs are: enlargement of the hilar shadows, mottling appearing in the middle and lower lung fields, patchy infiltrations, and in the later stages an enlarged pulmonary conus, enlarged heart, and pleural effusion.

Five cases are reported.

SYDNEY J. HAWLEY, M.D.

**Roentgenographical Pulmonary Changes in Periarteritis Nodosa.** Tore Svanberg. Acta radiol. **26:** 307–312, March 31, 1945. (In English.)

To the rather scanty literature on periarteritis nodosa in the lungs the author adds 3 cases, in 2 males and

1 female, 58, 56, and 53 years of age, respectively. Roentgen examination revealed increased vascular markings, rather coarse centrally but thinning peripherally, with interspersed irregular areas of infiltration. In one case the changes were predominantly on the right side, while in the others they were evenly distributed over both lungs. F. ELLINGER, M.D.

**Loeffler's Syndrome—Eosinophilic Pneumonia. Case Report.** Sidney Scherlis. Mil. Surgeon **96:** 349–354, April 1945.

A case of Löffler's syndrome in a 24-year-old soldier is reported. Roentgenograms on the second day of the illness showed diffuse soft changes throughout the entire extent of both lung fields. Films taken nine days later showed complete clearing.

**Blast Injury to the Lungs: Clinical and Radiological Findings and Their Relation to Certain Symptoms.** G. R. Fearnley. Brit. M. J. **1:** 474–477, April 7, 1945.

The author presents a review of 21 cases of blast injury of the lungs with an initial comment on the pathology of this condition, *i.e.* hemorrhage due to capillary rupture. In the cases discussed, though the clinical picture was clear enough, the individual symptoms and radiological findings varied considerably. In the usual case there was unconsciousness followed by dyspnea or a "blown up" sensation with retrosternal and muscular pain, cough, hemoptysis, and epistaxis. The physical signs were not remarkable. The x-ray findings in most instances consisted of dense shadows in the right or left base, suggesting fluid. The shadows were not specific and had not the patchy appearance of pneumonia. There was no relation between the severity of symptoms and the appearance of the chest film. Treatment was symptomatic. Q. B. CORAY, M.D.

**Pulmonary Concussion. ("Blast") in Non-Thoracic Battle Wounds.** Oswald Savage. Lancet **1:** 424–429, April 7, 1945.

In a series of 87 autopsies on battle casualties, the majority with penetrating head wounds, 30 instances of "blast" changes in the lungs were discovered. In none had there been external evidence of thoracic damage, and clinical signs of pulmonary abnormality had been remarkably sparse. In no case did hemoptysis occur. The pulse rates had been only slightly raised, and the blood pressures were within normal limits, but in many instances there was some respiratory distress with stertorous breathing. Physical signs in the chest were minimal and confined to adventitious sounds scattered over the lung, but more pronounced at the base. In the later cases, when routine chest films were taken in patients who might have been exposed to blast, typical radiological changes, consisting of a diffuse, rather "fluffy" mottling, were sometimes observed. It was found constantly at autopsy that the hemorrhages were more widespread than the ante-mortem pictures suggested. Such an x-ray appearance is caused not only by blast hemorrhages but is consistent with scattered bronchopneumonia, silicosis, and other conditions.

At autopsy, the lungs were large and in the majority the surfaces showed no change, but on sectioning a striking "spatter" of hemorrhages was seen. In some these had coalesced to form areas of consolidation, always in the lower lobes and frequently only in the posterior costophrenic fringes. Circular areas of hemorrhage about 1 cm. in diameter were scattered throughout the lung. They were darker in the more consolidated center, with a brighter red and ill-defined edge fading off into the normally colored lung. To obtain a record of the distribution of the hemorrhages, many of the lungs were reinflated and studied roentgenographically. Two types of pictures were seen. One showed scattered opacities, sometimes confined to one lobe; in the other, not only were scattered opacities present but in parts the hemorrhages were so numerous that an appearance of consolidation was produced. In these latter areas the larger bronchioles were patent.

In the 30 cases, evidence of blast hemorrhage elsewhere in the body was seen 10 times. The liver was found bruised in 6 patients. Hemorrhages on the surface of the heart were seen 4 times. Small areas of hemorrhage were seen in the pancreas, spleen, and colon, each on one occasion. In every case where an abdominal organ was implicated, there was bleeding into the retroperitoneal tissues.

In 9 of the 30 cases with pulmonary changes the blast was assessed as severe, in 10 as moderate, and in 11 as slight. In 10 per cent of the 87 cases, therefore, it was considered that blast lung played a considerable part in causing death and in another 10 per cent a small part. Bronchopneumonia occurred in 4 of the moderate cases but in none of the severe cases. Sulfadiazine, given to prevent cranial sepsis, may have helped prevent this complication, also.

**Primary Bronchiogenic Carcinoma.** Alton Ochsner, J. Leonard Dixon, and Michael DeBakey. Dis. of Chest **11:** 97–127, March–April 1945.

Primary bronchiogenic carcinoma has become one of the most frequent and important primary malignant lesions. Its incidence is increasing both relatively and absolutely. It occurs predominantly in males, and largely in the sixth and seventh decades. The authors attribute the growing incidence chiefly to the increase in smoking and the inhalation of tobacco smoke, and support this view by references to the literature.

Pulmonary carcinoma is almost entirely a disease of the bronchi, although rarely it may begin in the alveoli. Most bronchiogenic carcinomas are located in the region of the hilus, and the right side is more frequently involved than the left. The tumor is usually slow growing and remains localized for a long period. Metastasis takes place (*a*) by direct extension, (*b*) through the bronchial lumen, (*c*) by implantation (biopsy or operation), and (*d*) through the blood and lymph streams; the sites most frequently involved are the regional bronchial and mediastinal lymph nodes (in about 70 per cent of the cases). Because of this, surgery offers a fairly good prognosis.

There is no characteristic clinical picture. The most frequent symptoms are cough, loss of weight, previous respiratory infection, hemoptysis, dyspnea, and pain in the chest. The physical findings vary with the location and extent of involvement. Every respiratory disturbance in a patient past forty, which cannot be explained, should be investigated with the possibility of primary bronchiogenic carcinoma in mind. Roentgen examinations are important, though in early cases they may show nothing. The film may show a shadow produced by the tumor itself, by metastatic mediastinal nodes, or by an area of atelectasis. Occasionally a small peripheral tumor not large enough to cast a shadow will give rise to a large mediastinal mass which may be interpreted as a primary lesion. The most reli-

able method for diagnosis is bronchoscopy and biopsy. Bronchography is also a valuable diagnostic method, especially when the mass casts no shadow and cannot be visualized by bronchoscopy. In suspected cases, expectorated material should be examined microscopically for tumor cells; also, a pleural effusion when present. Aspiration biopsy is condemned.

The only curative treatment of pulmonary carcinoma is surgical removal of the involved lung. Irradiation has little or no curative value; it may, however, produce palliation and should be reserved for inoperable cases and those in which surgery is definitely contraindicated.

The authors quote extensively from the literature and present graphically their own observations. They have performed 52 pneumonectomies and report 22 patients still living, 4 for five years or longer.

HENRY K. TAYLOR, M.D.

**Difficulties in the Differential Diagnosis of Bronchogenic Carcinoma.** Robert G. Bloch, William E. Adams, Thomas F. Thornton, and J. Edmond Bryant. J. Thoracic Surg. **14:** 83–97, April 1945.

Six cases are presented in some detail to illustrate the difficulties in the differential diagnosis of bronchiogenic carcinoma. Many roentgenograms are reproduced showing the roentgen problems. The authors advocate routine chest roentgen examinations in all hospital and clinic admissions. They believe, however, that the final diagnosis can never be established by roentgen methods and that, if bronchoscopy fails, surgical exploration is the only reliable diagnostic procedure. Early lesions are illustrated, closely simulating tuberculosis, lung abscess, and pneumonia. Clinical findings are not of decisive value, especially in the early cases.

HAROLD O. PETERSON, M.D.

**Hamartoma (Often Called Chondroma) of the Lung.** John R. McDonald, Stuart W. Harrington, and O. Theron Clagett. J. Thoracic Surg. **14:** 128–143, April 1945.

The term hamartoma was coined in 1904 by Albrecht, who stated that "hamartomata are tumor-like malformations in which occurs only an abnormal mixing of the normal components of the organ. The abnormality may take the form of a change in quantity, arrangement, or degree of differentiation, or may comprise all three." The word hamartoma is derived from a term which means to fail or err.

Previously reported hamartomata in the lung were made up chiefly of cartilage and have therefore been called chondromas. Since these tumors have many and occasionally all the elements of the adult bronchus, it is felt they should not be regarded as true teratomas, especially since they are not found in the mediastinum. They are frequently subpleural in the lung, and the small ones simulate a Ghon complex roentgenologically. The size varies, and the masses are usually lobulated and well circumscribed. The tumors are all benign.

The authors had 23 cases available for study. In 3 of these the tumor was removed surgically, and in 20 the lesion was discovered at necropsy. These 20 cases were found in a series of 7,972 necropsies.

Only occasionally are symptoms produced by these tumors. They can be found by roentgen studies, but a final diagnosis can be made only by histological examination. Surgical removal is advocated unless there is some contraindication. In the authors' experience with lung tumors they have found no other which approximates the pathological appearance of a hamartoma.

HAROLD O. PETERSON, M.D.

**Case of Besnier-Boeck-Schaumann Syndrome, or Benign Lymphogranulomatosis, with Pneumothoraces.** James Isbister. M. J. Australia **1:** 275–277, March 17, 1945.

The author reports a case of bilateral pneumothorax occurring in a patient with sarcoidosis. The diagnosis of sarcoidosis was made on the basis of the roentgenographic appearance of the lungs, roentgen evidence of bony involvement, an increase in total serum protein content, a negative Mantoux test, and failure to isolate tubercle bacilli. No peripheral lymphadenopathy was present and there were no skin lesions; hence no biopsy material was available.

The patient, a female 19 years old, was first seen in December 1940 complaining of loss of weight and energy and of insomnia, progressing over a period of four to six months. The temperature was 101° F., but there were no other abnormal physical findings. Roentgen examination revealed extensive discrete infiltration through both lungs, of productive type, suspected of representing pulmonary tuberculosis. Blood studies revealed nothing unusual except for a shift to the left on the Arneth count. No tubercle bacilli were found in the sputum on two examinations. Gradual improvement occurred during the next year and serial roentgen examinations revealed a progressive resolution of the pulmonary lesions.

In January 1943, the patient enlisted in the Women's Australian Auxiliary Air Force. Her general condition was good and a photofluorograph of her chest on a 35-mm. film was passed as normal. She was admitted to an Air Force Hospital in October 1943 because of dyspnea on exertion and pain in the left chest. Radiographic examination showed a partial pneumothorax on the left, causing displacement of the heart, and also a diffuse mottling or "marbling" of both lungs, particularly toward the basal regions. No tubercle bacilli were found in 6 specimens of sputum or in the fasting gastric contents. Radiographic examination of the hands and feet revealed a small cystic area in the head of the 1st metatarsal bone and another at the base of the proximal phalanx of the 2d digit of the same foot. The fasting blood serum protein content was 8.5 gm., of which the albumin fraction was 6.2 gm. and the globulin fraction 2.3 gm. per 100 c.c. After two weeks rest in bed the left lung had fully expanded. Six weeks later a right-sided pneumothorax occurred; this also responded to rest in bed, and the patient was well at the time of the present report, with no other clinical manifestations of disease.

The pathology, prognosis, and treatment of sarcoidosis are briefly discussed. Histologically the typical picture is one of a granulomatous lesion, and necrosis is not a usual feature. In healing, the sarcoid nodule either resolves and disappears completely or may become replaced by fibrous tissue. It is therefore difficult to explain the occurrence of pneumothorax in the case reported. A possible explanation is obstruction to a terminal bronchiole with alveolar emphysema leading to rupture into the pleural cavity, or the presence of necrosis of a subpleural focus. H. H. WRIGHT, M.D.

**"Beriberi Heart" in a Tuberculous Patient.** Jason E. Farber and D. K. Miller. Am. Rev. Tuberc. **51:** 315-320, April 1945.

"Beriberi heart" is characterized by dilatation of the heart associated with signs of cardiac failure, a normal or accelerated circulation rate, electrocardiographic changes, and a response to specific vitamin therapy (thiamine). There may be evidence of other B-complex deficiencies which simplifies the diagnosis.

A case is reported in which pulmonary tuberculosis appeared to be the precipitating factor. The patient had been bedridden for months, his appetite had been poor, and he had had a mild peripheral neuritis of the lower extremities. An acute cardiovascular syndrome developed, characterized by left ventricular failure and pronounced cardiac dilatation. There was no response to digitalis but after treatment with thiamine and yeast, improvement was rapid. Death occurred three months later from tuberculosis. L. W. PAUL, M.D.

**Cardiac Hypertrophy and Extramedullary Erythropoiesis in Newborn Infants of Prediabetic Mothers.** Herbert C. Miller. Am. J. M. Sc. **209:** 447–455, April 1945.

Infants born of diabetic mothers sometimes have at birth cardiac hypertrophy, extramedullary erythropoiesis, adrenal hyperplasia, increased eosinophilia of the anterior hypophysis, and hyperplasia of the female genital organs, as well as increased body weight and hyperplasia of the islands of Langerhans. The diagnosis of this syndrome in infants born to mothers who have not yet developed diabetes is of importance not only in directing the care of the infant in the neonatal period, but also in anticipating the onset of diabetes in the mother.

In the 7 cases reported, no mother had any symptoms of diabetes before or during the pregnancy in question, and only one had glycosuria. Signs and symptoms developed in the mothers from two days to five years following the birth of the infant. In all but one instance, the onset of diabetes was gradual.

Five of the infants died. At least one of the abnormalities noted above was present in each case. Although the findings are the same in the infants whether or not maternal hyperglycemia has been established, the absence of diabetic symptoms and signs in the mothers makes the diagnosis of the syndrome in the children more difficult. This difficulty can be partly overcome by anticipating the presence of the syndrome in infants with an excessive birth weight and with cardiorespiratory symptoms. The routine use of roentgen studies of the heart and normoblast counts when the birth weight is 4,500 gm. or more, and when cyanotic spells, dyspnea, and tachypnea occur during the neonatal period, regardless of birth weight, will greatly aid in establishing the diagnosis. Since the heart size diminishes rapidly and the normoblasts disappear from the peripheral blood relatively early, both studies should be initiated the first or second day after birth.

The size of the heart returns to normal in the first or second month of life, and the cardiorespiratory symptoms, when present, do not persist beyond the first ten days of life, in contrast to the findings in infants with congenital malformations of the heart or its great vessels.

An excessive normoblastemia may be associated with sepsis, syphilis, and premature birth. Erythroblastosis foetalis may make the differential diagnosis difficult, but anemia or jaundice is usually present in that condition.

BENJAMIN COPLEMAN, M.D.

**Radiographic Examination of a Case of Cancer of the Thymus.** Axel Renander. Acta radiol. **26:** 297–301, March 31, 1945. (In German.)

This case report concerns a male patient 75 years of age. The radiographic symptoms differed somewhat from those given by previous authors. The diagnosis cancer of the thymus was corroborated by autopsy.

F. ELLINGER, M.D.

## THE DIGESTIVE SYSTEM

**A New X-Ray Method of Studying the Anatomy and Motility of the Stomach and Duodenum: Its Diagnostic Value.** Walter Farkas Gruber. Am. J. Digest. Dis. **12:** 127–137, April 1945.

The stomach is divided by radiologists and clinicians into three parts, the fundus, the corpus or body, and the pars pylorica. The fundus is divided from the body by an imaginary straight line drawn from the lower end of the esophagus to the greater curvature, while the body of the stomach is divided from the pars pylorica by an imaginary line drawn from the incisura angularis to the greater curvature.

In order to study the anatomy of the stomach and its behavior under the influence of local mechanical stimuli, the author took balloons of different sizes, attached them to buckles of Rehfuss tubes and inserted them into the fasting stomach. He filled them with varied amounts of air and, after giving the patient barium, studied the behavior of the stomach by means of roentgenograms.

It was found that the stomach could be divided into the three parts mentioned above, which as functional unities are connected with each other anatomically as well as physiologically. These parts could be further subdivided into segments. It was also proved that a rhythmic segmentation exists in the stomach as in the intestines. The subdivision of the body of the stomach and pars pylorica was shown by transverse folds as well as by different phases of dilatation and contraction.

In observing the stomach radiologically, one must take into consideration that it is not only part of a transport system but also a chemical plant and its muscles must contract powerfully around ingested food so that it may exert its chemical function.

When barium is ingested, the stomach reveals only the changes that are characteristic of its function as a transport system. If, however, a balloon is inflated in the pars pylorica, the effect is the same as if solid food were ingested, and haustral segmentation appears. By inserting a balloon and filling it with 30 c.c. of air, the author was able to produce a systolic contraction of the entire pars pylorica. It not only became narrower but shorter, proving that both the circular and longitudinal muscles contracted at the same time.

When a balloon was inserted into the fundus and body of the stomach and filled with air, the muscles of the pars pylorica relaxed in proportion to the amount of air introduced until they reached a state of inertia. When the duodenum was distended by a small balloon the sphincter contracted and the pars pylorica and body of the stomach relaxed.

The oblique muscle, which is continuous with the

circular muscle of the esophagus, forms a sling around either side of the lesser curvature. The author observed contraction of this muscle when the balloon was located beneath the incisura angularis and inflated and when it was inflated in the body of the stomach. When the oblique muscle relaxed, the longitudinal muscle contracted. The circular muscle was seen to contract and form sphincter-like areas.

The author has studied the human stomach in 44 cases by means of balloons filled with air. Several cases are recorded in which he was able to find gastric ulcer or carcinoma where it would otherwise have been difficult or impossible to detect.

JOSEPH T. DANZER, M.D.

**An Experiment in the Early Diagnosis of Gastric Carcinoma.** Fordyce B. St. John, Paul C. Swenson, and Harold D. Harvey. Ann. Surg. **119:** 225–231, February 1944.

In an attempt to discover symptomless cases of gastric cancer, 2,432 persons were examined roentgenologically at Presbyterian Hospital, New York. Subjects of the study were persons over the age of fifty who had no significant digestive symptoms (visitors to the hospital and patients who had been treated for conditions other than gastric). So far as possible, persons were included who ordinarily would not have received a gastro-intestinal study. Four hundred and ninety-one of the series were re-examined, making a total of 2,923 examinations. Nineteen individuals with important gastric symptoms were admitted to the study in error and were deducted from the final tabulations.

The examination consisted of rapid fluoroscopy of the stomach. In the first thousand cases a single stomach film was also made, but as nothing was found on any of the films that had not been observed fluoroscopically, this practice was discontinued. The authors believe that an experienced roentgenologist rarely requires more than a minute to satisfy himself that he is dealing with a normal stomach. If the stomach appeared normal, the patient was dismissed. If any suggestion of abnormality was seen, he came back for further careful study at a later time. The examination was made in the erect position only, unless something suspicious was found in the fundus, in which case the patient was also examined prone.

Among the 2,432 cases, 3 unsuspected malignant gastric tumors (2 cancers, 1 lymphosarcoma) were encountered; so far as is known, no tumor was missed. The lymphosarcoma was manifested fluoroscopically as a persistent area of flattening near the pylorus. This was confirmed by further roentgen studies, but at operation the surgeon was unable to recognize any lesion, even with the stomach opened, and therefore did not resect. Some months later, at the site of the suspicious roentgen finding, an obvious tumor developed, which was then resected. The two carcinomas were very small and had not metastasized; both were resected.

Five other patients had gastric resections after extensive roentgenologic study and in most instances conservative therapy and gastroscopy, and were found to have only benign ulcers. These cases illustrate the difficulty in making an exact diagnosis in gastric lesions, even with all the diagnostic aids available.

Five hundred and twenty-eight abnormalities other than cancer were discovered, the greater percentage being functional. However, 54 instances of deformed duodenal bulb without symptoms of ulcer, 7 cases of cardiospasm, and 25 cases of diaphragmatic hernia were found.

The cost of the examination was approximately 48 cents a person, but this does not include the roentgenologist's services or the overhead charges for roentgenologic equipment.

**Intestinal Obstruction by Gall-Stones.** Maurice Lee. Brit. M. J. **1:** 555–556, April 21, 1945.

The author points out that intestinal obstruction by a gallstone is rare but has the highest mortality rate of all intestinal obstructions. Reference is made to a series of 646 cases in which intestinal obstruction was the primary diagnosis. In only 40 of these was the condition due to a gallstone. The author's patient was an 87-year-old man without significant gallbladder symptoms.

The fistulous opening is usually into the duodenum. The stone, a large one where obstructive symptoms occur, starts down the intestinal canal and lodges intermittently in the narrower places, at which time symptoms become apparent. The author points out that vomiting and abdominal pain continuing over a period of 24 hours may be considered evidence of a serious condition. The x-ray is helpful in diagnosis in demonstrating small intestinal stasis and gas; at times, the stone can be shown. The treatment is immediate surgery.

Q. B. CORAY, M.D.

**Pathology of Regional Ileitis.** G. W. H. Schepers Am. J. Digest. Dis. **12:** 97–116, April 1945.

The author reports a case of regional ileitis and presents an elaborate study of the pathological aspects of this condition based on his own observations and a review of the literature. The disease has two components: (1) a *primary phase*, characterized by (*a*) a stage of edema of the submucosa and serosa with dilatation of submucosal lymphatics and hyperemia of juxtamuscular adventitial blood vessels; (*b*) *a stage of plasma-cell infiltration* of the submucosa and serosa; (*c*) diffuse fibrosis, with disappearance of the plasma cells, except where trapped; (*d*) healing; (2) a *secondary phase*, characterized by ulceration superimposed on any of the primary phases, with corresponding modification of the pathological process. There are tendencies to early or late perforation, fistulization, and granuloma formation.

A critical analysis of possible etiological factors suggests that the primary disturbance is either due to acute injury of the bowel wall by a metabolite, probably lipoid in character, or results from a neuropathic disturbance involving Auerbach's and/or Meissner's plexuses, or mesenteric and celiac ganglia. In nature the original neuropathic lesion is possibly a type of visceral herpes zoster. It is suggested that the chronic type of secondary ulceration occurs only when ganglionic lesions are destructive as well as irritative, thus leading to denervation of the affected bowel wall.

**On the Reduction of Ileal-Ileocolic Intussusception by Means of Contrast Enema.** E. Dahl-Iversen and Børge Fogh. Acta radiol. **26:** 293–296, March 31, 1945. (In English.)

In the experience of the authors, reduction of an ileal-ileocolic intussusception by means of contrast enema is only exceptionally accomplished. They cite a series of 28 cases of intussusception in the ileocecal region, of which 11 proved to be irreducible by contrast enema;

9 of the latter group were found at operation to be ileal-ileocolic intussusceptions, while the 19 cases which were reduced were shown roentgenographically to be ileocecal. A case is also reported in an infant of three months which was irreducible by enema as far as the terminal portion of the ileal segment was concerned. In this case the intussusception into the small intestine was demonstrable radiographically.

In referring to reported examples of conservative reduction of ileal-ileocolic intussusception, the authors state that they cannot accept such a diagnosis unless an unmistakable demonstration is given of the ileal intussusception before complete reduction.

F. ELLINGER, M.D.

## ABDOMINAL INJURIES

**Radiology of War Injuries. Part 1. War Wounds of the Abdomen.** D. B. McGrigor and Eric Samuel. Brit. J. Radiol. **18:** 65–75, March 1945.

An analysis of 25,000 war casualties showed 12 per cent of the injuries to be abdominal. Of this group, 80 per cent were penetrating wounds, with a 70 per cent recovery rate. The recovery rate for non-penetrating wounds was 90 per cent. Two per cent of the casualties involved both the thorax and abdomen, and in this group there were 50 per cent recoveries.

Radiological examination can be of assistance in locating foreign bodies, indicating the track of missiles and the possibility of damage to the viscera, and demonstrating the presence of pneumoperitoneum, associated lesions of the chest, extraperitoneal injuries (ruptured kidney), and postoperative obstructions. Examinations for wounds of the upper abdomen should include the lower chest and those for wounds of the buttocks and upper thighs should include the lower abdomen.

A supine film, including the diaphragm, a lateral film, and an erect film (with the patient sitting if he cannot stand), or, if this is not possible, a horizontal anteroposterior film with the patient lying on his side, should be made in each case.

Stab wounds were comparatively unusual in World War II, the majority of perforating wounds being due to missiles. These were caused chiefly by fragments of shells, mortars, and bombs, and the abdominal injuries thus produced carried a far more serious prognosis than bullet wounds. Fragments of the light alloy covering of incendiary bombs may go no further than the abdominal wall, but the symptoms (guarding, rigidity, tenderness) may closely simulate intra-abdominal injury. In such cases careful study of the roentgen film may prevent unnecessary laparotomy. Anatomical structures, as indriven ribs, may also act as missiles, causing severe visceral damage, and fractures of the pelvic girdle may involve the peritoneal cavity.

While the clinical diagnosis of penetrating abdominal wounds is usually obvious, radiology, as pointed out above, will often furnish valuable aid. The radiographic appearances depend upon the relative extent to which solid and hollow viscera are involved. Among the roentgen features listed by the authors are: pneumoperitoneum, which, however, is seldom seen on films taken within twelve hours of a penetrating injury; gas distention of the bowel above the site of injury, while the bowel below is empty; retroperitoneal hematoma demonstrable as a large soft-tissue mass displacing the gas-filled bowel.

Estimation of the missile track by observation of the wounds of entrance and exit may be useful, but it is to be borne in mind that the intervening course may be extremely tortuous. Nor should too much reliance be placed on demonstration of a foreign body, to the neglect of other evidences of injury.

Abdomino-thoracic wounds may be classified as (*a*) injuries caused by separate missiles, (*b*) missiles entering the thorax and emerging from the abdomen and the reverse, (*c*) transverse wounds of the chest involving the diaphragm and the upper abdominal organs, and (*d*) tangential wounds of the lower chest with indriving of the ribs. Wounds of the chest at or below the nipple may involve the diaphragm and abdominal structures. The possibility of diaphragmatic hernia must always be borne in mind.

Non-perforating injuries may involve either a hollow viscus or a solid organ, injuries to the spleen being the most common. Radiology finds its chief application in cases of doubtful diagnosis, in which the operative indications are not clear. Films should be examined for free gas in the peritoneum, abnormal collections of gas in the bowel, retroperitoneal hematomata, and renal injuries.

The results of blast injuries, though more common in the skull and chest, are also observed in the abdomen. Multiple intra-intestinal and intraperitoneal hemorrhages have been observed, and the radiologic appearance may be that of paralytic ileus. Immersion blast injuries are also discussed.

Postoperative ileus and obstruction are common after abdominal wounds. Their character and degree are best estimated by radiography.

The author quotes extensively from the literature and includes a bibliography and numerous roentgenograms with brief case histories. SYDNEY J. HAWLEY, M.D.

## THE MUSCULOSKELETAL SYSTEM

**Sclerosing Sarcoma of Bone. (Dangers of Biopsy.)** James F. Brailsford. Brit. J. Radiol. **18:** 8–10, January 1945.

Sclerosing sarcoma of bone occurs most commonly at about the age of twenty. The radiographic appearance is typical, showing sclerosis of bone with or without radiating spicules of new bone formation. In this type of sarcoma prompt amputation gives the best results.

Biopsy is not advisable, as it is frequently misleading, showing no evidence of sarcoma. It weakens the stability of the bone; it does not assist in predicting metastasis, and it may disseminate tumor cells, thus adding to the risk to the patient. Three illustrative cases are presented. SYDNEY J. HAWLEY, M.D.

**Renal Osteodystrophy. Report of a Case of Unusual Pathogenesis.** John J. Castronuovo. Arch. Pediat. **62:** 156–166, April 1945.

The author chooses the term renal osteodystrophy to designate cases of osseous disorder associated with renal insufficiency. In the literature such cases have been termed, also, renal rickets, renal dwarfism, and renal osteitis fibrosa cystica.

The renal lesions show evidence either of embryologic maldevelopment or of long-standing infection with insufficiency. Some of the genito-urinary lesions reported have been: hypoplasia with cyst formation, congenital polycystic disease, congenital valves of the urethra, ureteral strictures, and glomerulonephritis. Hypertrophy of the parathyroids seems to have been a

rather constant finding and is considered to be secondary to the renal insufficiency.

The bone lesions correspond in general to those of osteitis fibrosa cystica. In addition to these, one finds in children changes suggestive of those seen in rickets, as knob-like swellings at the epiphyses, knock-knee, bent wrists and ankles.

Acidosis is common; the phosphorus level is usually somewhat elevated (4–16 mg.); the calcium is normal or decreased. The calcium phosphorus ratio is somewhat less than normal.

The author gives in detail a case history, but does not show any reproduction of x-ray films. It is the opinion of the abstractor that the average roentgenologist would rather see one typical film than to read many thousands of words of analytical discussion, however scholarly. PERCY J. DELANO, M.D.

**Diseases of the Vertebral Column: A Roentgenologic Analysis.** Albert Oppenheimer. Am. J. Roentgenol. **53:** 348–369, April 1945.

The diseases of the spine may be regarded as vertebral localization of bone and joint disease and can be classified as (1) diseases of vertebral bone; (2) diseases of vertebral symphyses; (3) diseases of vertebral synovial joints; (4) diseases of vertebral ligaments. In general, the morphological appearances and clinical manifestations of a given vertebral disease correspond to those of the same disease involving other bones and joints. Under the above classification, the author describes and illustrates many of the diseases as they involve the vertebral structures. Thus, tuberculosis is primarily a necrosing lesion in the vertebra, as elsewhere. Owing to its cancellous structure and abundant blood supply, the vertebral body is involved more frequently than the neural arch, and this is true in other diseases as well. Lesions of the vertebral symphyses may have their origin either in the bone or in the disk. Bone disease close to the horizontal vertebral surface leads to involvement of the disk mainly by interference with disk nutrition.

The various types of arthritis occur in the apophyseal joints and their roentgen and clinical manifestations are the same here as in other true joints.

Of the lesions of the vertebral ligaments, only calcification and ossification are disclosed roentgenologically. These are common reactions and not characteristic of any particular disease and are apparently the result mainly of disuse of the ligaments. L. W. PAUL, M.D.

**Uncovertebral Osteophytes and Osteochondrosis of the Cervical Spine.** Ernst Lyon. J. Bone & Joint Surg. **27:** 248–253, April 1945.

This paper deals with the observation of 40 patients showing localized hypertrophic lesions peculiar to the cervical spine and first thoracic vertebral body, which the author terms "uncovertebral osteophytes." Uncovertebral osteophytes occur at the lateral and posterolateral lips of the vertebrae, on their superior surfaces. Normally these surfaces are concave, with elevated lateral margins known as processus uncinati. The osteophytic change occurring in these processes is degenerative in nature. It is thought that interference with the spinal nerves may be the cause of the syndrome, consisting in neuralgic pains in the arms, neck, and back of the head.

Osteochondrosis is characterized by a degenerative, destructive process of the intervertebral disk as a whole, with fibrillation, dehydration, and fissuring, resulting in marginal bone proliferation of the lateral lips of the cervical bodies.

Roentgenologically there are decrease in height of one or several of the lower vertebral bodies and narrowing of the intervertebral spaces. There are also atrophy, bone lipping of one or several uncovertebral osteophytes, and marginal proliferations on the inferior surface of the body above that affected. Oblique views are necessary to demonstrate the uncovertebral osteophytes. JOHN B. MCANENY, M.D.

**Myelography by the Use of Pantopaque in the Diagnosis of Herniations of the Intervertebral Discs.** Arthur B. Soule, Jr., Sidney W. Gross, and James G. Irving. Am. J. Roentgenol. **53:** 319–340, April 1945.

Pantopaque, a recently introduced contrast medium for myelography, has been used by the authors in 118 cases. The technic for introduction and removal of the substance is essentially the same as that described by Kubik and Hampton for lipiodol (New England J. Med. **224:** 455, 1941. Abst. in Radiology **37:** 654, 1941). Pantopaque has certain advantages over other media. It flows more readily than lipiodol, can be easily moved by slight changes in the position of the patient, and tends to outline the nerve root sheaths and minor defects better. Because of its low viscosity, it is easily injected and withdrawn. In most of the cases the majority of the pantopaque was removed following completion of the roentgenographic examination. No untoward effects were noted in any of the patients when removal was not complete.

The various types of defects encountered in lumbar and cervical disk herniations are described and illustrated. Pantopaque has been of particular value in the diagnosis of herniation of the cervical intervertebral disks. By proper manipulation of the patient, it can be pooled in the cervical area and it shows less tendency to break up into globules than lipiodol.

L. W. PAUL, M.D.

**Observations on Opaque Myelography of Lumbar Disc Herniations.** D. C. Eaglesham. Brit. J. Radiol. **17:** 343–348, November 1944.

For demonstration of herniated disks in the lumbar region, the opaque medium (lipiodol or pantopaque) should be injected in the interspace between L2 and L3 or L3 and L4, as most herniations are found at L4 or below. To avoid an extradural injection, 0.5 c.c. may be injected and a brief fluoroscopic examination made. If the oil moves freely the full injection may then be carried out. In most instances 3 c.c. are adequate, but 5 to 6 c.c. are preferable.

Removal of the oil may be easy or difficult. In patients with flat spines a small pillow may be placed under the chest and hips to increase the curvature. This will assist in collecting the oil in a dependent place. If the needle is placed too superficially, the oil will not be recovered. Sometimes rotating the patient a little to one side or the other will be helpful.

Four types of defects are observed in the oil column: displacement, indentation, block, and lack of filling of the axillary pouch or nerve root sheath.

Indentation of the column is the commonest. It may be unilateral or bilateral. The size of the indentation may change with change of position.

Displacement is rare, occurring only with large herniations with deep indentation or some degree of block.

In the presence of block the oil may be pinched up into a point or there may be an abrupt transverse termination of the column. The block in the column is sometimes seen well above the disk space level.

Lack of filling of the nerve sheaths may be due to herniation of the disk but it may also occur normally. Usually it is associated with deformity of the oil column. Root sheaths not seen on the first examination may fill and be seen at later examinations if the oil is not removed.

The deformities caused by extradural and subdural injections may lead to errors in diagnosis. Another source of confusion appears when the spinal fluid escapes into the subdural space producing a long narrowing of the column. SYDNEY J. HAWLEY, M.D.

**Lateral Prolapse of the Cervical Intervertebral Disc.** Hugh Davies. Brit. J. Radiol. **18:** 1–4, January 1945.

Lateral herniation of the nucleus pulposus in the cervical region may cause pain by pressure on the nerve roots. Such herniation is often associated with marginal lipping and loss of joint space.

Four cases are reported in which the chief complaint was pain in the shoulder radiating down the arm. Myelography (with pantopaque) showed lateral filling defects, indicating lateral herniation of the disks. In two of the cases no abnormality was evident on the plain film.

As these cases show a spontaneous tendency to recovery, surgery is not advised. Head traction and a supporting collar may give relief.

SYDNEY J. HAWLEY, M.D.

**Congenital Absence of the Pectoralis Major.** Eric Samuel. Brit. J. Radiol. **18:** 20–21, January 1945.

Congenital absence of the pectoralis major on one side may give rise to confusion if the radiologist does not make a physical examination. This is particularly apt to occur in mass surveys. The roentgen appearance is that of an abnormal translucency of the upper half of one hemithorax which may be interpreted as emphysema. Two cases are presented.

SYDNEY J. HAWLEY, M.D.

**Arachnodactyly (Spider Fingers).** H. Gray. Arch. Int. Med. **75:** 215–221, April 1945.

A case of arachnodactyly, or spider fingers, in a ten-year-old boy with congenital dislocation of the lenses and a congenital cardiac peculiarity, is presented. The physical build of this patient was carefully studied by means of anthropologic measurements and the data are compared with the normal and with other cases of arachnodactyly recorded in the literature. [Since the publication of this paper an interesting account of arachnodactyly occurring in a father and two daughters has appeared in RADIOLOGY (Parker and Hare: Radiology **45:** 220, September 1945).]

**Calcification of the Tendon Cuff of the Shoulder.** M. Beckett Howorth. Surg., Gynec. & Obst. **80:** 337–345, April 1945.

One hundred cases of calcareous degeneration in the tendon cuff of the shoulder are reviewed, and the symptoms, signs, roentgenographic appearances, and etiologic factors are considered. Twenty-three of these cases were treated surgically and their pathology is discussed. The results of treatment by surgical and nonsurgical procedures are reported.

The tendon cuff is composed of the tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles, which fuse with the capsule of the shoulder joint about an inch from its distal margin. Calcareous degeneration in this tendon cuff is a frequent and disabling lesion and a common cause of so-called subdeltoid bursitis. Calcareous deposits were found in the bursa itself in only one of the cases reported. The symptoms, signs, and roentgenographic features of the lesion are considered characteristic. The degeneration in the tendon cuff is probably due to attrition from the use of the arm at the side, with repeated, sudden, jerky movements.

The calcareous material found in the tendon cuff is suspended in liquid in the early acute cases, and the roentgenographic shadow is "cumulus cloud-like" and fairly homogeneous. The deposit is granular and infiltrating in the chronic cases, and the shadow is fragmented and irregular in outline and density. Roentgenograms should be made in 45 degrees internal and 45 and 90 degrees external rotation, as well as in the neutral position, since a single view may fail to show one or more of the calcifications.

Relief from pain and spasm, and absorption of the suspended calcareous material may often be obtained in the early acute cases by rest, heat, diathermy, cold, ethyl chloride spray, or radiotherapy. The chronic cases are not likely to be helped by such measures. Repeated or intensive radiotherapy is undesirable, as it may increase the degeneration or damage the overlying skin. Massage, stretching, and manipulation are likely to increase the pain, spasm, and limitation of motion, and to damage the shoulder. Rupture of the calcareous deposit into the bursa spontaneously, or with treatment, will give immediate relief. Aspiration, irrigation, or puncture may relieve pain through drainage and reduction of tension. Novocain injection relieves pain only temporarily unless the calcareous material is drained at the same time. Operative removal of the calcareous material is the surest and quickest method of relief, particularly in the chronic cases. Complete removal of the deposit is desirable for the best results. Special exercises should be used with any of the treatments, for preservation of strength and restoration of motion in the shoulder and arm.

R. E. BOOTH, M.D.

**The Internal Epicondylar Epiphysis and Elbow Injuries.** Adolf A. Schmier. Surg., Gynec. & Obst. **80:** 416–421, April 1945.

Fracture dislocations of the elbow in children are frequently accompanied by displacement of the internal epicondyle into the joint. Recognition of such displacement is of the first importance if a well functioning elbow is to be insured. For this purpose, detailed roentgenograms made in various positions are essential.

In early cases both the dislocation and the epicondylar displacement are easily reduced by the closed method described by the author. This is based on the fact that the internal humeral epicondyle gives origin to a group of muscles which pronate the forearm, flex the wrist and fingers, and aid in flexing the elbow. The procedure consists in turning the forearm in supination and extending the elbow, wrist, and fingers. At the same time, the forearm is gently abducted, thus increasing the gap between the trochlea and ulna and allowing the epicondyle a free route of exit from the joint. In late cases, adhesions will bind the displaced

epicondyle to the joint and open reduction will be necessary. The possibility of some loss of motion in this event is strong.

The degree of damage in these cases varies with the severity of the trauma. In the least serious cases the epicondyle is only slightly separated. When the trauma is more severe, the epicondylar epiphysis may be pulled down to below the the articular level of the elbow by flexor muscle pull. The internal lateral ligament may be strained or torn. With greater valgus strain, it is possible for the elbow to open momentarily on its medial aspect so that the epicondyle becomes wedged in the joint between the trochlea and the sigmoid fossa of the ulna.

The author reports 5 cases. All but one of these was successfully treated within twenty-four hours of the injury by the closed method. One patient was first seen three weeks after injury, when it was too late to attempt closed reduction, and open operation was required; intra-articular changes precluded a satisfactory result. FRANCISCO BASSOLS, M.D.

## GYNECOLOGY AND OBSTETRICS

**Radiographic Manifestation of Tuberculous Salpingitis.** Wolfgang Magnusson. Acta radiol. **26:** 265–278, March 31, 1945. (In German.)

Salpingograms of 12 patients suffering from tuberculous salpingitis, verified by histologic examination after surgical removal of the tubes, have been compared with 200 salpingograms obtained from patients suffering from tubal occlusion from other causes. It has been observed that finely indented and ragged contours, defects of the lumen the size of a grain of rice or smaller, and fistula-like dilatations are evidence of tuberculosis. On the basis of these manifestations tuberculous salpingitis can be diagnosed radiographically in the majority of cases.

F. ELLINGER, M.D.

## THE GENITO-URINARY TRACT

**Excretory Cysto-Urethrograms.** John W. Draper and Joseph G. Siceluff. J. Urol. **53:** 539–544, April 1945.

The authors present a method of studying the anatomy of the bladder and urethra and the physiology of micturition. In their particular technic, five separate roentgenograms of the lower urinary tract are made. The patient voids and is placed in the supine position on a tilt table. He is catheterized and the residual urine is measured. The bladder is distended with 120–180 c.c. of air until the patient notes distention, when a clamp is put on the catheter. An air cystogram is then made in the oblique position. The air is then evacuated and is replaced with a contrast medium, usually 15–20 per cent Skiodan, until the patient has a normal desire to urinate, at which time a roentgenogram is made in the oblique position with the patient voiding contrast medium. The patient is next asked to stop voiding and a roentgenogram is made as he contracts the sphincter muscles. He is instructed to void again, and a fourth exposure is made during voiding against the obstruction produced by a penis clamp. Following this the patient is allowed to empty his bladder, and a final film is exposed to demonstrate any opaque material which may remain.

Some excellent illustrations achieved by this method are included, showing inflammatory and traumatic strictures of the urethra, diverticula of the bladder, and incompetent sphincters. R. E. BOOTH, M.D.

## THE BLOOD VESSELS

**Clinical Anatomy of the Vertebral Veins.** Martin Norgore. Surgery **17:** 606–615, April 1945.

The various explanations offered for the spread of so-called "paradoxical metastasis" have, until recently, been unsatisfactory. How, the author asks, do metastases reach the cervical spine from carcinoma of the prostate without deposits in the lung, or carcinoma of the breast metastasize to the spine without lymph-node involvement?

The rediscovery of the vertebral vein system by Batson (see Ann. Surg. **112:** 138, 1940) demonstrated clearly the connection between this system and other venous systems and offers a plausible explanation for such metastatic spread. The author repeated Batson's experiments, injecting the dorsal vein of the penis in 5 cadavers, with Wehr's artist's water-color vermilion. In 4 of the specimens serial x-rays of the body showed that the injected mass flowed through the veins along the pelvic girdle as far distant as the head of the femur, along the vertebral column, and finally inside the cranium, without entering the vena cava. In the fifth the material entered the vena cava and did not proceed up the spinal column.

The transportation of cancer cells or a bacterial embolus against the usual direction of the blood stream, as in the invasion of the cranium by a bronchiogenic carcinoma, is explained by a reversal of flow in the vertebral system of veins, which was shown to occur under certain circumstances, as sneezing, coughing, or straining. The absence of valves in the spinal veins is also an important factor, as it enables the blood to pass in either direction and consequently greatly increases the freedom of circulation.

The author concludes that there is a fourth system of veins, namely, the vertebral or meningorachidian system, in addition to the caval, portal and pulmonary systems, through which tumor cells or infected emboli are sometimes spread to distant parts, and that this system of veins furnishes an anatomic explanation for so-called "paradoxical metastasis."

J. E. WHITELEATHER, M.D.

**Arteriography for the Demonstration of Intracranial Aneurysms.** Robert M. Lowman and Simon D. Doff. Am. J. Roentgenol. **53:** 341–347, April 1945.

The clinical diagnosis of intracranial aneurysm is difficult and, in the past, most of these lesions have been discovered during operations for other intracranial conditions. The introduction of cerebral arteriography by Egas Moniz in 1927 (see Rev. d'oto-neuro-opht. **11:** 746–748, 1933) opened a new approach and since then many cases have been diagnosed by this method.

The authors have employed cerebral arteriography in 15 cases. Because of possible dangers from the use of thorotrast, a 50 per cent solution of diodrast is recommended as the contrast agent. Fifteen cubic centimeters of this solution is injected into the internal carotid after surgical exposure of the vessel. When approximately three-quarters of the material has been injected, the first film is exposed and a series of three

or four exposures is obtained as rapidly as the cassettes can be changed. A case of an aneurysm of the internal carotid is reported in which cerebral arteriography gave valuable diagnostic evidence. L. W. PAUL, M.D.

**Peripheral Aneurysm of the Pulmonary Artery.** Arne Clausen. Acta radiol. **26:** 324–327, March 31, 1945. (In German.)

A case is reported, in a woman of 69 years, of an aneurysm in the pulmonary artery perforating into the bronchus of the lingual lobe. On the roentgenogram the aneurysm is seen as a rounded isolated area of rarefaction in the pulmonary parenchyma. An autopsy report is included. F. ELLINGER, M.D.

**A Method for Determining the Blood Pressure in the Pulmonary Artery.** Nils Westermark. Acta radiol. **26:** 302–306, March 1945. (In English.)

By taking a series of roentgenograms of the lungs in various projections and with varying intrabronchial pressure, checked by a water manometer, the main branches and the stem of the pulmonary artery are found to be compressed at a given pressure for each individual tested. This pressure corresponds to the blood pressure in the pulmonary artery, in healthy persons being 25–30 mm. Hg. In patients suffering from mitral lesions the pressure was found to be augmented. F. ELLINGER, M.D.

**Arteriography in Renal and Abdominal Conditions.** O. A. Nelson. J. Urol. **53:** 521–530, April 1945.

The author describes the technic of arteriography of the abdominal organs by aortic injection and reports his experience in 106 cases. A pressure apparatus is used for injecting the solution through an 18-gauge needle 12 cm. long. The x-ray unit must have the potential power to deliver 500 ma. and the Bucky diaphragm speed to permit an exposure of 0.25 sec. The contrast medium used is an 80 per cent solution of sodium iodide.

By way of preparation the patient is given 60 c.c. of castor oil in 90 or 120 c.c. of root beer the afternoon before the examination and allowed only liquid nourishment thereafter. The solution is placed in a glass tube and the pressure brought up to 1.5 atmospheres. A scout film of the abdomen in the supine position is made. Under sodium pentothal anesthesia, the needle is introduced just below the twelfth rib and three or four fingers' breadth to the left of the spinous processes. The point of the needle is directed inward and downward toward the twelfth vertebral body and when the bone is encountered the point is deviated laterally so as to glide over the vertebra. The stylet is then withdrawn and the needle advanced slowly a few centimeters to enter the aorta. After blood comes through the needle, it is advanced another 0.5 cm. and the pressure apparatus is attached. The outlet valve is opened and 6 or 8 c.c. of contrast solution is allowed to run in, the exposure being made just as the injection is completed. The pressure apparatus is then disconnected and after a few cubic centimeters of blood runs out the needle is withdrawn. By using a lead shield over the Bucky diaphragm two films may be exposed at two- or three-second intervals.

Three hazards are described: acute iodism, which is combated by an intravenous infusion of 1,000 c.c. of 5 per cent glucose in normal saline with 200 units of vitamin C after the patient has been returned to bed; extra-aortic injection of contrast media, and extravasation through the needle puncture. Extra-aortic injection caused pain but the hypertonic solution is absorbed in a short time. Owing to the ruggedness of the aortic wall, perforation with an 18-gauge needle does not cause leakage.

Diodrast, 70 per cent, and skiodan were tried and failed to afford clear delineation of the smaller arteries but did produce dense shadows of the renal parenchyma. Forty cubic centimeters of diodrast, 70 per cent, injected into the aorta will produce satisfactory urograms in patients with inadequate renal function to permit visualization by intravenous injection.

The use of arteriography is described in the location of organs, arterial obstruction, aneurysm, and renal neoplasms which cannot be detected on pyelograms. Five arteriograms are presented showing a retroperitoneal tumor, obstruction of the renal artery, an aneurysm of the abdominal aorta, and two cases of renal neoplasms undetected on pyelograms.

The importance of training in the dissecting room before attempting aortic puncture on patients is emphasized, and the need for study and experience in interpretation of arteriograms is noted. Properly performed, the author believes that aortic puncture should carry no more hazard than a spinal puncture or a cystoscopy. FRANK P. BROOKS, M.D.

## GAS GANGRENE

**X-Rays in Diagnosis and Localisation of Gas-Gangrene.** F. H. Kemp. Lancet **1:** 332–336, March 17, 1945.

During the last war a number of observers noted that it was possible to detect gas in the tissues by means of x-rays, but this in itself is not enough for the diagnosis of gas gangrene, since there are several other conditions which give rise to gas in the soft tissues.

Any fresh wound, even a tiny needle puncture, may permit air to enter the tissues. Sometimes gas crepitation may be detected clinically, or bubbles may be seen in the depths of the wound, but in most cases roentgenography is necessary. On the roentgenogram the air appears as radiotranslucent bubbles, pockets, or streaks in the soft tissues. It is seldom confined to the track of the wound, but is widely dispersed in the surrounding loose cellular spaces. It may extend throughout the entire length of a limb, but it never infiltrates the muscles unless it is forced in under pressure.

The amount and distribution of air in the tissues vary according to whether the wound is open or closed, and with the amount of tissue loss. In civilian casualties air in the tissues is seldom detected, because the roentgenogram is usually taken to show the bones, and definition of the soft parts is obscured or lost in the blacker parts of the negative. A still more important reason is that the injured part is usually put at rest by efficient first-aid, thus preventing movements, active or passive, which tend to suck air into the tissues. Air may be seen in any muscular wound which communicates with the respiratory passage. Once the injured part is placed completely at rest, air is quickly absorbed. In twenty-four hours the amount has diminished considerably, and within three days all but a trace is gone.

Air can be introduced by changing a pack, removing a stitch, or by irrigation. In one case it was introduced during the manipulation of an intramuscular penicillin drip. Soft paraffin gauze tends to impair the absorption of air and holds it in pockets on the skin or in the wound. Thus the treatment adopted must be considered when assessing the significance of gas bubbles in the tissues.

Local formation of gas in the depths of a wound by gas-forming organisms gives roentgen appearances which closely resemble those given by air, and differentiation is usually impossible except by serial roentgen examinations, and even then the observer must be acquainted with all the details of the treatment subsequent to the accident. Local gas formation does not necessarily mean invasion of the living tissues by organisms for, as a rule, bubbles form in a hematoma, around a foreign body, or in dead tissue. In such cases there may be no clinical signs of infection and the roentgen signs do not in themselves demand surgical intervention.

True gas gangrene is a progressive infiltration of muscles and the loose cellular tissues with gas-forming organisms. As the infection spreads through living tissues, there develops a severe toxemia which, if allowed to continue, brings about the death of the patient.

In the heavier parts of the body it is easy to miss one or many gas bubbles in a single anteroposterior projection. To avoid mistakes the greatest care must be taken to examine the patient clinically and rotate the limb or position the tube so that the suspected part is uppermost. A projection taken from the side is probably the most important. In experiments on a human cadaver, it was found that as much as 3 c.c. of air in the muscles of the thigh might escape detection in a single anteroposterior roentgenogram, but lateral projections showed bubbles as small as 0.25 c.c.

Anyone who has studied soft-tissue films of the injured should be aware of the normal relative translucencies between the main groups of muscles; these are due to fat. In some patients, especially old or middle-aged persons with flabby muscles, the roentgenograms show multiple linear streaks in the muscles which are due to fatty replacement; this picture at first glance may resemble the appearance of acute fulminating gas gangrene but, if care is taken to examine the whole limb, it will be seen that the change is not confined to any one group of muscles and bears no relationship to the clinical signs. A film of the opposite limb for comparison is of assistance.

After an injury, there are often local collections of free fat in the loose cellular spaces around the injured part. This fat is revealed as radiotranslucent patches or streaks in the tissues. As a rule, the translucency is not so great as that produced by gas, but at times it is difficult to detect a difference. Bubbles almost always mean gas, but streaks or irregular translucent patches may be due to gas or fat. In serial films, the air is found to disappear quickly, whereas fat may persist for several days. If there is a fatty accumulation in a joint, *i.e.*, a lipohemarthrosis, the fat tends to rise to the surface to form a top layer and a lateral view taken from the side shows a fluid level; this picture resembles air in the joint. In fat people, especially in the region of the buttock, roentgenography may reveal many linear streaks in a bruised muscle which are due to fat; these resemble the earliest stages of gas infiltration of a muscle and cannot be distinguished by a single roentgen examination.

It is difficult to decide when gas-forming organisms have begun to invade the loose cellular tissues. The fact that a wound is dirty, inflamed, and foul smelling means only that inflammatory reaction is taking place. Gas crackling in the subcutaneous tissues or bubbling from the depths of the wound is not necessarily due to gas-forming organisms, for it may be merely air. Even the presence of anaerobic bacteria means nothing beyond the fact that the wound is infected, and many wounds so infected show no trace of gas. Anaerobic cellulitis almost always accompanies true gas gangrene, and gas formation in the loose cellular tissues can often be detected roentgenographically in advance of an infection of the muscles, with little clinical evidence of its presence except when the gas is subcutaneous.

The most important fact which radiology establishes is that gas in the tissues does not necessarily indicate anaerobic infection of the wound, and that in the majority of cases the gas is really air. These points are easily appreciated if there are no clinical signs of infection but easily overlooked if there is any cause for anxiety. When a surgeon discloses discolored and friable muscles in a wound which is two or three days old, it may seem very suspicious to find bubbles of gas, but if there are no signs of invasion of the healthy tissues, it is almost certainly safe to do no more than resect the damaged tissues. A doubtful case should be kept under constant clinical and roentgenographic observation.

In every accident case admitted to a hospital, roentgen examination should be done at least once, preferably as soon as possible after admission. Every patient who complains of increasing local pain or discomfort in the tissues around his wound should be re-examined. Three-hourly examinations are usually sufficient, but in some instances, where the clinical course changes rapidly, it may be necessary to examine the patient every hour.

Seven cases of gas gangrene are reported. In 2, there was an acute fulminating infection of living tissues. In both, the vascular supply to the part was not seriously impaired, the development of the infection was extremely rapid, the toxemia profound, and within a few hours of the recognition of the disease the patients were dead. The roentgen findings in the other 5 cases bore no strict relationship to the degree of toxemia. In 2 cases, the x-ray pictures were almost identical and the distribution of gas was similar; yet one patient was desperately ill while the other was only slightly toxic. In the one case the infection had spread from the dead to the living tissues and toxic absorption could readily take place, whereas in the other the infection was minimal. In 2 cases, amputation of the limb was necessary because part of it was already dead; the anaerobic infection of the muscles in these cases would have been important if operation had been delayed and the infection had spread to the living tissues. Two cases illustrate the importance of repeated examinations of a dead limb while waiting for a line of demarcation; in both of these cases the development of anaerobic infection in the dead tissues precipitated operation, for both patients were beginning to show signs of toxemia.

Roentgenograms are reproduced.

## TECHNIC

**Automatic Exposure Control in Photofluorography.** Russell H. Morgan. Dis. of Chest **11:** 150–155, March-April 1945.

Photofluorographic examination of the chest is greatly facilitated by the introduction into the x-ray

circuit of a photoelectric timing mechanism, or phototimer, which replaces the conventional timing device. The mechanism consists of a multiplier phototube and a condenser-thyratron-relay system. This device is capable of terminating the x-ray exposure when a sufficient quantity of radiation has reached the screen. The phototube is a camera device located in the hood and focused on a cross-wise area of the middle and adjacent upper portion of the screen. During the exposure, the rays from the screen are not only focused on the fluorographic camera, but also on the timing device. As a result of a sufficient quantity of radiation on the screen, a current is set up and conducted by the phototube. The magnitude of the current is proportional to the intensity of the fluorescent radiation. This current is collected by a condenser, whose potential increases as a result of collected charges. At a given potential, the thyratron becomes conductive and permits a current to pass through the field coils of a relay. This opens the relay contacts and terminates the x-ray exposure.

The predetermined density or radiation effect is controlled by the operator. Exposures are either short or long, depending upon the brilliance of the fluorescent screen. Optimum diagnostic quality is obtainable by adjusting the sensitivity of the phototube, the size of the condenser, and the potential at which the thyratron becomes active.

Practically, the machine is set at the beginning of the day (at 90 kv., 500 ma., for example). Thereafter, the technician places the patient, closes the x-ray switch, and the phototimer automatically controls the exposure. This eliminates measuring the thickness of patients and adjusting the machine with every exposure. It makes for uniform results, reduces to insignificant proportions the number of retakes, and reduces personnel operating photofluorographic units by 50 per cent.

[Morgan and Hodges published an evaluation of automatic exposure control in RADIOLOGY for December 1945 (Vol. 45, p. 588).] HENRY K. TAYLOR, M.D.

**Tomography.** J. B. McDougall. Edinburgh M. J. **52:** 127–131, March–April 1945.

The author believes that tomography is a valuable supplement to routine radiological and fluoroscopic examination in the diagnosis and interpretation of pulmonary lesions. The apparatus and technic are described.

**A Simple Apparatus for Body Section Radiography.** Percival A. Robin. Mil. Surgeon **96:** 273–275, March 1945.

An easily constructed and inexpensive device for obtaining body section roentgenograms is described. This apparatus consists of three parts, adapted to fit the Keleket W-2 table and 6A tube stand; minor changes in construction, however, permit adaptation to any standard equipment. The principles of operation are given, together with certain technical factors.

**Diagnostic Use of Radioactive Common Salt.** Gunnar Sohrne. Acta radiol. **26:** 279–285, March 31, 1945. (In English.)

A method for the study of the circulation in different vascular regions by the use of radioactive sodium chloride and a Geiger-Müller counter is described. The method appeared particularly useful in the diagnosis of brain tumors, for determining whether or not the tumor is vascular. F. ELLINGER, M.D.

## RADIOTHERAPY

### NEOPLASTIC DISEASE

**Radium Treatment of Cancer of the Oesophagus.** M. Lederman and J. Clarkson. Brit. J. Radiol. **18:** 22–28, January 1945.

This paper is based in part on the contribution of Lederman to a Discussion on the Treatment of Carcinoma of the Oesophagus before the Royal Society of Medicine (Proc. Roy. Soc. Med. **37:** 331, 1944. Abst. in Radiology **44:** 103, 1945). The indications for treatment of pharyngo-esophageal tumors, mid-esophageal tumors, and cardio-esophageal tumors are repeated here and a fairly detailed account of the method of introducing the radium bougie for tumors in the mid-esophagus is included. This requires a meticulous technic. The site and location of the tumor must be accurately determined. The lumen of the esophagus must be adequate to take a 28 French catheter, as smaller sizes do not allow as good dose distribution. The bougie must fill the whole length of the esophagus, as otherwise it tends to be displaced upward. The tubes should have a linear density of 10 mg./cm. A divided dose is employed, the bougie being inserted on alternate days and shifted in position to equalize the distribution of the dose.

Of 15 patients with pharyngo-esophageal cancer, 3 were alive and symptom-free after one year. Of 38 with mid-esophageal tumor, 1 lived two and one-half years and the remainder died within six months. Of 15 with cardio-esophageal cancer, 1 was alive after five years and 1 survived one year and five months but died with the disease. In commenting on the results in mid-esophageal cancer the author points out that survival figures do not give the true picture, since "the rapidity with which the symptoms are relieved, and the avoidance of gastrostomy, are of incalcuable value to the patient." SYDNEY J. HAWLEY, M.D.

**Results of Irradiation of Ovarian Tumors.** H. Dabney Kerr and Robert A. J. Einstein. Am. J. Roentgenol. **53:** 376–384, April 1945.

The results of combined surgical and roentgen treatment of 100 consecutive patients with carcinoma of the ovary, diagnosed clinically or pathologically, are reported. The cases are tabulated according to age distribution, clinical grouping, pathologic diagnosis, radiation dosage, and survivial rates. The majority of the patients received a tumor dose of more than 2,000 r. No relationship was found between the tumor dose and the rate of survival. From the authors' experience and that of others, as found in the literature, there seems to be a definite relationship between the clinical stage of the disease and the rate of survival. It is generally agreed that postoperative irradiation results in a definite improvement in the five-year survival rate. This improvement is most noticeable in those groups in which total removal of all primary and metastatic tumor tissue was impossible, in recurrent tumors and in those entirely inoperable when first seen.

It is concluded that irradiation should be given in all cases of malignant ovarian tumor, but only after the removal of as much neoplastic tissue as possible. Preoperative irradiation is indicated only in advanced inoperable cases. L. W. PAUL, M.D.

**Electroendothermy as an Adjuvant to Radiotherapy in Uterine Cancer.** S. Thorén. Acta radiol. **26:** 249–264, March 31, 1945. (In English.)

The use of electrosurgery (fulguration) is suggested in the treatment of uterine cancer. The author reports 70 cases of cancer of the cervix and 3 cases of cancer of the corpus uteri treated at the Radiumhemmet in Stockholm and followed for at least four years. On the basis of this experience, electrosurgery appears particularly suitable in patients offering a poor surgical risk because of complicating disease and in cases where radiation therapy has failed, especially in those in which it is impossible to differentiate between a recurrence and radium necrosis. Eleven cases in which radiation therapy failed were cured by electrosurgery for at least four years. F. ELLINGER, M.D.

**Wilms' Tumor of the Kidney.** Roy G. Giles, Urol. & Cutan. Rev. **49:** 217–220, April 1945.

Four patients with Wilms' tumors were admitted to the Robert B. Green Memorial Hospital (San Antonio, Texas) within a five-year period. In 2 the disease was too far advanced for any form of treatment and in 1 case therapy was refused. One child lived twenty-three months following a combination of preoperative irradiation, surgery, and postoperative irradiation.

MAURICE D. SACHS, M.D.

**Roentgentherapy of Hemangioma of the Larynx in Infants.** H. H. Kasabach and C. P. Donlan. J. Pediat. **26:** 374–378, April 1945.

Two cases of hemangioma of the larynx in infants, successfully treated by roentgen irradiation are presented. The symptoms of hemangioma of the larynx, in the order of frequency, are obstructive dyspnea, inspiratory stridor, a hoarse cry, croupy cough, blood-tinged mucus, gross hemorrhage and fever if there are pulmonary complications. In the differential diagnosis of laryngeal stridor in infants, one must consider other causes, such as a small glottic lumen, congenital web below the glottis, macroglossia, laryngeal papilloma or cyst, enlarged thymus, mediastinal tumor, and foreign body. In the presence of fever, perilaryngeal abscess and acute infections must be ruled out.

After the obstructive dyspnea has been relieved by a low tracheotomy, irradiation, either by radium or x-ray, may be started. The authors believe that if 1,200 r can be delivered to the site of the lesion, roentgen therapy is the treatment of choice because of its simplicity and accuracy of application. Should irradiation fail, surgical removal, preferably by thyrotomy, must be considered.

Eight other cases of hemangioma of the larynx in infants are tabulated.

**Roentgen Therapy of Boeck's Sarcoid.** Ernst A. Pohle, Lester W. Paul, and Elizabeth A. Clark. Am. J. Med. Sc. **209:** 503–513, April 1945.

The cause of sarcoid and its relationship to tuberculosis remain in dispute. The lesions may involve any organ or system in the body but show a predilection for the reticulo-endothelial system, especially the lymph nodes. The basic lesion is the epithelioid cell tubercle with occasional giant cells of the Langhans type, without caseation and only occasionally with some central necrosis. Because of the microscopic appearance, the diagnosis of hyperplastic or non-caseous tuberculosis is often made. The mediastinal lymph nodes and the pulmonary tissues are probably the most frequent sites of involvement.

The treatment of the disease has usually been empirical, including various drugs and such modalities as hyperpyrexia and irradiation by ultraviolet and roentgen and radium rays. The latter have been successful in the treatment of the skin lesions. While x-ray irradiation has in the past not proved beneficial, several recent reports have appeared which offer greater hope.

Eight cases (only 2 proved by biopsy) treated by the authors are reported in detail. Two of these were progressive for almost two years before roentgen therapy produced a favorable result. Objective evidence of regression appeared in from two to four months after therapy was instituted. It was preceded in nearly all cases by clinical improvement. Six treatments were given of 150 r (in air) to anterior and posterior mediastinal ports (15 × 20 cm.), one area being treated daily, (175 kv.; half-value layer 1.05 mm. Cu). This series of treatments was repeated in from six to eight weeks. Other nodes usually were given 3 × 150 r (in air), with treatments daily or every other day, the series being repeated once or twice at intervals of four to six weeks.

The therapeutic result was excellent in 1 case, good in 4 cases, satisfactory in 1 case, and fair in 2 cases. No untoward reactions were observed. The authors are therefore encouraged to make further trial of x-ray therapy and advocate its use by other radiologists.

BENJAMIN COPLEMAN, M.D.

## NON-NEOPLASTIC DISEASE

**Tendogenetic Disease and Its Treatment with X-Rays.** J. Borak. New York State J. Med. **45:** 725-729, April 1, 1945.

In tendogenetic disease, of which so-called "frozen shoulder" is the most familiar example, the degeneration and necrosis of the tendon give rise to a peritendinitis of the surrounding sheath, which in turn may spread to other structures, as, in the case of the shoulder, the walls of the bursa subacromialis, the sheath of the tendon of the deltoid, and the fibrous layers of the joint capsule. In such cases, x-ray therapy is directed not to the necrotic tendon but to the inflammatory process in the tendon sheath, walls of the bursa, and neighboring structures.

This inflammatory process presumably starts as a simple serous exudate but usually goes on to a precipitation of fibrinogen, with strands of fibrin loosely binding together the walls of the bursa and adjacent structures. It is upon these fibrin strands that the x-rays act indirectly, through dilatation of the capillary walls and an increase in their permeability. This is followed by an increased flow of plasma from the blood, carrying along lymphocytes, monocytes, and leukocytes which have the power to phagocytize and to carry away the fibrin and the necrotic tissue debris.

Two varieties of tendogenetic disease are recognized—the calcified and non-calcified. For treatment purposes the author subdivides the cases with calcifica-

tion into three groups. (1) Cases with complete or nearly complete immobilization of the affected part (typical "frozen shoulder") respond to a dose even as small as 100 r, calculated at the bursa, given on two or three consecutive days, but it may be advisable to add 200 r on two successive days to prolong the duration of the post-irradiation edema and thus to increase the number of cells functioning as phagocytes. One portal of entrance is sufficient in these cases. Even very large deposits may then gradually disappear without further treatment. (2) In more chronic cases, with restricted mobility of the arm, a dose of 200 r, calculated at the bursa, is given six to eight times at intervals increasing from two to four days. Two portals of entrance, one anterior and one posterior, are required in these cases. After a month, a new series of treatments is added, if necessary, until the deposit is substantially reduced in size and density, and the pain on moving the arm has considerably subsided. (3) In the third group of cases pain is experienced only at the extremes of the range of motion, when the arm is raised over 80 degrees. For this chronically stationary condition, a dose of 250 r, calculated at the bursa, is given eight times at intervals of two days. Three portals of entrance, one anterior, one lateral, and one posterior, are required. After about six weeks, a new series of treatments is added in accordance with the course of the symptoms.

The non-calcified variety of the disease resembles clinically the calcified type and responds similarly to roentgen therapy. Tendogenetic disease elsewhere than in the shoulder calls for the same treatment. As in the case of the shoulder, the degree of impairment of motion is the main criterion of dosage.

**Some Roentgenologic Considerations Pertaining to Upper Extremity Pain.** Charles F. Behrens. J. A. M. A. **127:** 888–890, April 7, 1945.

In this paper the author considers particularly symptoms referable to changes in the cervical vertebrae and thinning of the intervertebral disks consequent upon arthritic changes of degenerative hypertrophic type. Cervical arthritis has been found to be a fairly frequent cause of upper extremity pain. In the author's opinion either narrowing of the disk or productive changes significantly located may be factors in the mechanism of this condition. He suggests, in addition, that round-cell infiltration, passive congestion, and perhaps some degree of fibrosis—in other words, some degree of chronic inflammation—may often be more important than osteoid proliferation and thinning of the disks.

Diathermy and the usual methods of treatment have been found of little value in the treatment of these cases. Careful manipulation, traction, and massage produce much better results, and roentgen irradiation has proved one of the most effective methods of treatment. The action of the x-rays doubtless is on the irritated and congested soft tissues about the affected segments. Diminution of swelling and improvement of circulation reduce the pressure on the nerve roots, thereby relieving the pain. Any effect on the purely mechanical pressure from arthritic spurs or due to the thinned disks is not to be expected. Symptoms from disorders of the cervical vertebrae are often slower to respond to irradiation than those from the so-called subdeltoid bursitis. Changes in the roentgen appearance of the cervical lesions has been negligible in the author's experience.

Generally, 75 to 100 r, twice a week at first and later weekly, are given (200 kv., 0.5 mm. Cu and 3 mm. Al filtration, 60 cm. distance). After six to eight treatments, a rest period of about six weeks is allowed, followed by a second course. Not all cases will be helped by roentgen therapy. Either extreme—giving up before an adequate amount of radiation has been administered (even up to 2,000 r in stubborn cases) or persisting unduly in the face of a poor response—must be avoided.

**Roentgen Therapy as an Adjunct in the Management of Acute Postpartum Mastitis.** Roger A. Harvey, Howard A. Spindler, and Andrew H. Dowdy. Surg., Gynec. & Obst. **80:** 396–403, April 1945.

The authors report 100 cases of acute postpartum mastitis receiving roentgen therapy in addition to the usual conservative measures in 1942–1944. They compare the results to those in 15 cases treated by conservative methods alone during the same period and 77 cases similarly treated during the preceding sixteen years.

Among those who received roentgen therapy the duration of symptoms was 1.9 days; in the others, without suppuration, 8 days. The incidence of breast abscess in the irradiated group was 1.5 per cent and in the others, 20 per cent. The cost per infected breast among the hospitalized cases was $17.22 at ward rates and $27.50 at private rates for those not irradiated, exclusive of the attending physician's or surgeon's fee; in those who received roentgen therapy it was $9.12 at ward and $19.35 at private rates, including the radiologist's fee. Among ambulatory patients the cost to those treated with irradiation was $4.60 ward and $11.50 private rates.

Two types of initial infection were encountered; a superficial type following cracked nipples and abrasions and a deep or glandular type due to stasis within the ducts. After twenty-four to thirty-six hours most patients had a mixture of the two types.

The authors emphasize the importance of treatment early in the course of the disease and advise aspiration in cases which show any suggestion of suppuration after forty-eight hours. If no pus is obtained the patient is treated, but the chance of suppuration developing is 50 per cent. If pus is found, one or two preoperative treatments of 150 to 200 r each may be given. The authors do not believe in prophylactic irradiation in questionable cases. Two roentgen-resistant cases responded to sulfonamides.

The initial dose in the series varied from 40 to 100 r. Small doses were given to the more acutely ill patients. Those with small flat breasts or with a superficial type of infection only were treated at 120 kv., 10 ma., 3 mm. aluminum filtration, and 21.5 to 40 cm. target-skin distance. The other patients were treated at 200 kv., 25 ma., 0.5 mm. copper and 1.0 mm. aluminum filtration, and 50 cm. target-skin distance. The area treated included most of the breast and the lymphatic drainage related to the involved area. The time interval between treatments was usually twenty-four hours, but in cases in which the temperature continued to climb, another 50 r was given in the same day. One to 5 treatments were given per breast, with an average of 2.3. The total dose varied from 40 to 400 r, with an average of 165 r. Indications for more than one treatment included continued fever, residual pain and tenderness, and an elevated leukocyte count. Erythema was not a safe indication, as it might persist twenty-four to seventy-two hours after symptoms subsided. If there

was no response after thirty-six to forty-eight hours, roentgen therapy was discontinued.

Nursing from the infected breast was stopped during the acute phase, usually from six to eighteen hours. Breast pumping every eight hours was permitted except in cases with primary areolar or periareolar infections. After forty-eight hours without response, lactation was stopped in both breasts. Breast binders were used during the acute phase. Ice packs were applied during the early painful phase and local heat later. Salicylates were used for sedation.

Leukocyte counts were taken at the onset and daily thereafter. Many patients reached a crisis four to eight hours after treatment.

FRANK P. BROOKS, M.D.

**Plastic Induration of the Penis.** K. Schourup. Acta radiol. **26:** 313–323, March 31, 1945. (In English.)

Of a series of 15 patients suffering from plastic induration of the penis, 12 were treated by roentgen irradiation (2 of these by irradiation and surgery) and 3 by surgery alone. The follow-up of the irradiated patients revealed 3 complete cures, 3 incomplete cures, and 4 failures. No follow-up was possible in 2 cases. Doses ranging from 100 to 250 r with 0.5 mm. Cu filtration were given in one exposure and repeated three times at intervals of two to eight days. This series was repeated, if necessary, after two to six months. The total dose usually amounted to 300 to 900 r.

F. ELLINGER, M.D.

## TECHNIC AND DOSAGE

**Standardisation of Technique in Radiotherapy.** Emil Ungar. Brit. J. Radiol. **18:** 76–84, March 1945.

Standardization of technic in radiation therapy is advantageous for purposes of more accurately determining both the surface and depth dose and distribution and for accurate reproduction of dosages in different patients. A standard technic should be as simple as possible to set up and should be capable of being applied to all patients with as little modification as possible.

Four standardized technics are presented, intended to be used in treating lesions of the vertebrae, with full details. These technics may be used in other parts of the body where similar relations obtain between the surface and the volume to be treated.

SYDNEY J. HAWLEY, M.D.

**Dosage Rate in Radiotherapy. A Symposium.** L. H. Gray, F. Ellis, G. C. Fairchild, and Edith Paterson. Brit. J. Radiol. **17:** 327–342, November 1944.

The dose in radiotherapy is defined by Gray as a measure of the energy dissipated either as ionization, excitation, or heat per unit volume of tissue irradiated. In radium or x-ray therapy the dose in r, in most cases, is proportional to the total number of ions per unit volume. These ions are not distributed at random, but are found along the track of the ionizing electron. The immediate effects are therefore highly localized and there may be small regions of a cell which are not affected even by large doses.

The dosage rate is the rate at which one passage of an ionizing particle is followed by the next. If the interval is long enough, the cell may have the power to repair the damage done by one particle before the next transit. Therefore, the time interval between successive transits rather than the dosage rate itself will determine the effect upon a given cell. Since radiation quality controls the number of particles crossing a volume of given size, the influence of dosage rate may sometimes be different for different qualities of x- and gamma-radiation. In such cases variation in dosage rate and quality with depth beneath the surface of the body may be interrelated quantities for a given primary beam of radiation.

Some biological factors may influence the effect of dosage rate. Thus, interrelated injuries may play a role. Since oxygen tension influences cell sensitivity, injury to the vascular structures early in the course of irradiation may influence the response of the malignant cells and thus alter the influence of dosage rate. Cyclic variations in sensitivity, changing the proportions of cells in a relatively sensitive or insensitive state, may affect the influence of dosage rate, as may the rate of intercurrent tissue growth and replacement and the rapidity of movement of body fluids.

Experimental attempts to determine the effect of dosage rate have failed to show consistent results. In experiments on the lethal effect on *Drosophila* eggs, the effect is apparently independent of the dosage rates between 5 and 120,000 r/m. Lethal effects upon *Aspergillus* spores and the decrease in growth rate of wheat seedling roots showed no difference between 20 and 40,000 r/m. Studies on other biological materials showed decrease in effect at lower dosage levels. Most of these experiments suggest that there may be a "tolerance dosage rate" below which the particular effect will not be produced, no matter how long the exposure. However, some of the experiments indicate that the duration of the exposure is as much a factor as the dosage rate itself. These conflicting results may be explained as follows: An end effect of irradiation such as cell death can probably result from a variety of initial injuries, some of which are reversible and some irreversible, and each of which is produced in lethal amounts at a particular dose level. If the irreversible lethal injuries happen to be produced at the lowest dose levels, the effect will appear dosage-rate independent. If the reversible injuries are the more easily produced, then a dosage rate dependence will be observed up to the point where the total dose has reached the lethal level for one of the irreversible injuries, beyond which there will be no further increase in mean lethal dose however great the increase in dosage rate.

Thorough studies on gene mutation have shown no dosage rate dependence. Certain types of chromosome injuries, however, are dependent upon dosage rate. Single break injuries are independent of fractionation and are proportional to the dose. "Exchange breaks," requiring the production of two breaks by separate ionizing particles, are markedly dosage-rate dependent.

The preponderance of evidence revealed with studies on biological material *in vivo* is that the effect of irradiation is not dependent upon dosage rate except for extremely low and extremely high rates. There are, however, as Ellis points out, certain advantages in the higher intensities from a practical point of view which indicate that a better end result may follow the use of higher dosage rates.

Fairchild's contribution to the symposium consists in clinical observations on a variety of malignant lesions, from which he deduces the following facts:

"(1) It is definite that various types of malignant tissue situated at various sites can be destroyed or

rendered inactive for periods up to five years by means of radiation applied at surface intensity up to 500 r/min. using radiation = H.A.V. 1.7 Cu and 2.05 Cu with single lesion doses of from 1,100 to 1,200 r.

"(2) It is definite that irradiation of a variety of deep-seated lesions at surface intensities up to 760 r/min. can destroy or render such lesions inactive over a period of five years when given in total surface doses of from 6,600 to 10,000 r in periods of from 7 to 12 days, using a radiation giving H.A.V. 2.05 mm. Cu.

"(3) It is definite that irradiation of normal tissues at intensities up to 500 r/min. does not cause a greater degree of damage than when given at intensity of the order of 20–40 r/min. as observed over a period of five years.

"(4) The fact that there are many advantages in being able to give a certain dose in one minute as opposed to 30, or even 15 minutes, must be self evident.

"(5) The systemic reaction following high intensity irradiation has been of a minor degree as compared with those following low intensity irradiation."

The closing contribution is that by Paterson, dealing with the effects on tissue cultures of prolonging the overall time of irradiation. Her experiments indicate "an improved effect following prolongation of time, and include a clarification of what may be the basis of this better effect—namely a greater uniformity of response in a group of irradiated cultures."

Since this symposium is more or less in the nature of an abstract itself, this review does not do it justice. Any one interested is urged to read the original.

SYDNEY J. HAWLEY, M.D.

**Photographic Methods Applied to Dosimetric Problems.** G. Spiegler. Brit. J. Radiol. **18:** 36–44, February 1945.

A photometric method may be used for dosimetry in certain situations where ionization methods cannot be used. This involves conversion of the densities on the exposed film into corresponding dose values, with the aid of the so-called characteristic curve of the emulsion. To obtain the latter, an exposure is made through a rotating sector disk. When the disk, driven by a motor, revolves, the x-ray beam impresses on the film a sequence of stepped densities. The densities measured under each ring are then plotted against the log differences of the corresponding dose values. For purposes of photographic dosimetry, the picture of the field of treatment is traversed by the photometer, the readings plotted against distance; on the same film the exposure through the sector-wheel yields the relation of the blackening-values to dose-values. Since normal x-ray film is too sensitive for the purpose, a process film 150 times slower is used. The slower film is subject to much less error due to chemical fog.

The method is useful in measuring uneven fields and in constructing suitable equalizing filters in high-output, short-distance conditions, such as contact therapy; in measuring the leakage through defects in the housing of an x-ray tube or a radium unit; and in determining the stray radiation outside of a deep therapy cone.

SYDNEY J. HAWLEY, M.D.

**Use of Radiographs for Dosage Control in Interstitial Gamma-Ray Therapy.** W. J. Meredith and S. K. Stephenson. Brit. J. Radiol. **18:** 86–91, March 1945.

Roentgenograms may be used to check the location of radium implants and also to check measurements made clinically. Usually a pair of films made at right angles to each other, one of which parallels the plane of the implants, is adequate. With two plane implants, one view should "look between" the planes. Occasionally oblique views may be needed.

In order to obtain the actual dimensions of an implantation, the magnification must first be ascertained. This can usually best be accomplished by the ring method. An opaque ring of known diameter is affixed in the plane of the implant. One diameter of the ring will show no foreshortening, so this diameter can be used to determine the amount of magnification. Other methods of estimating the magnification are the geometric, the direct needle, and the indirect needle methods. The geometric method calculates the magnification from the target-film and the needle-film distances. The direct needle method uses one of the needles in the same manner as a ring. The indirect needle method is used when all show some magnification or foreshortening, one needle known to be in the correct plane being used as a guide to estimate the magnification. Illustrations of the use of each method are given.

Photographic checking in this manner also allows correction for grossly irregular implantation.

SYDNEY J. HAWLEY, M.D.

**Behavior of Thimble Chambers When Used for the Measurement of Very Soft Radiation.** J. A. Victoreen, Z. J. Atlee, and E. D. Trout. Am. J. Roentgenol. **53:** 391–394, April 1945.

The trend toward lower inherent filtration by the use of beryllium windows in roentgen tubes has made necessary the study of the behavior of thimble chambers for very soft radiations. Such radiation has become available recently to the roentgen therapist in contact therapy apparatus. It was found that the standard Victoreen thimble chamber with red bakelite wall was not suitable for measurement of wave lengths much longer than 0.5 Angström effective and at 1.5 Angströms it read low by 50 per cent. An experimental beryllium wall thimble chamber is described with less wave length dependence, being only 10 per cent low at 1.5 Angströms.

L. W. PAUL, M.D.

## EFFECTS OF RADIATION

**Development of Sarcoma in Bone Subjected to Roentgen or Radium Irradiation.** C. Howard Hatcher. J. Bone & Joint Surg. **27:** 179–195, April 1945.

The experimental background of bone sarcoma following irradiation and the clinical literature are reviewed. Reports of 24 cases of bone sarcoma following irradiation were found. Curiously, in 17 of these cases roentgen therapy had been given for tuberculous arthritis, and in 1 for acute arthritis. The remaining 6 patients were exposed to radium; evidently these patients ingested or received injections of radioactive elements.

Three case reports are presented.

Case I is that of a male with a diagnosis of giant-cell tumor of the proximal epiphysis of the tibia, which was excised, with extensive postoperative x-ray therapy. The microscopic diagnosis was benign chondroblastoma. Six years later a mass in the same location was diagnosed as primary sarcoma in the proximal fibula and on amputation was found to be chondrosarcoma.

Case II is that of a female who had received an unknown amount of radium and x-ray treatment for a

giant-cell tumor of the distal right radius, followed in three years by surgical removal of the distal radius and operative correction of the deformity, seven years after the original diagnosis. No evidence of malignancy was found. Eleven years after the original diagnosis, the distal ulna showed a growth, which was excised and found to be a fibrosarcoma with tumor cartilage.

In Case III a mass developed at the anterior end of the right seventh rib, twelve years after a right mastectomy followed by irradiation. Excision proved the mass to be a chondrosarcoma.

In discussing the cases, the author admits the possibility of recurrence or metastasis, but is firmly convinced that the malignant changes were attributable to irradiation. Surgery is absolved, although it also was used in all cases. [Much can be said against the possibility of irradiation as the cause of the malignant change in all these cases.] JOHN B. MCANENY, M.D.

**Changes in the Uterus after Eradication of Endometrial Adenocarcinoma by Radiotherapy, with Particular Reference to an Infarct-Like Radionecrotic Plaque in the Lining.** John F. Sheehan, Herbert E. Schmitz, and Janet Towne. Arch. Path. **39:** 237–256, April 1945.

A thorough gross and microscopic study was made of 4 uteri excised after eradication of carcinoma of the endometrium by large doses of radium (about 6,000 mg. hr.) and of roentgen radiation (about 4,000 r in the midpelvis). Routine sections of 2 other irradiated uteri were also studied. A carcinoma of the endometrium in one of these was destroyed by radiation. The changes are described in detail. The original site of the carcinoma in 5 of the 6 uteri could not be determined.

A localized plaque-like area of radionecrosis, essentially an area of coagulation necrosis, was found in the lining at or near the level of the internal os in 5 of the uteri. This was believed in every instance to be due to radium radiations. Changes were produced in the plaque by hemorrhage and infection. Whether or not such plaques are true infarcts is a question.

In the myometrial tissues adjacent to the uterine plaque, two zones showing the effects of radiation were found: a superficial zone of hyalinization and edema with necrobiotic changes and a deeper zone of edema with atrophic changes. In the cervix a single zone of hyalinization was the usual finding. Vascular changes were seen in these zones but were not confined to them.

Other observations included some degree of chronic endometritis, chronic cervicitis, and endometrial atrophy; chronic metritis, mild and more or less focal, and other non-specific lesions, including squamous metaplasia of the endometrial epithelium in one case.

**Treatment of Post-Irradiational Ulcers by Radon Ointment.** A. G. S. Cooper and D. F. Robertson. M. J. Australia **1:** 297–300, March 24, 1945.

The treatment of post-irradiation necrotic ulcers by radon-impregnated vaseline as outlined by Uhlmann was adopted at the Brisbane General Hospital early in 1943. Results have been good in all cases except ulcers due to gross overdosage. The treatment has also proved effective in x-ray dermatitis and varicose ulcers and in chronic ulceration occurring in thermal burns and keloids.

Radionecrotic ulcers are divided into two types, immediate and delayed. The immediate ulcer usually follows overdosage or an orthodox dose of radiation in the presence of debilitating disease, restricted blood supply, or sepsis. The delayed ulcer is primarily due to an obliterating endarteritis and is often precipitated by infection, sunburn, or minor trauma.

The ulcers seen followed various forms of treatment with deep, superficial, and contact x-ray therapy, radium, and radon. A common sequence was found to be the interstitial application of radium followed by contact x-ray treatment for recurrence.

The objection that the radon ointment treatment adds further damaging irradiation to the area is proved fallacious by the results. The concentration used is no more than one-twentieth of an erythema dose. All scar tissue necroses respond in a manner similar to post-irradiation ulcers. The ionization produced is predominantly from the alpha rays. The mode of action is not entirely understood. It is believed that the alpha-ray therapy in small dosage promotes the growth of vascular tissues.

In preparation of the ointment, radon seeds 1 cm. long, of 0.5 mm. gold capillary, are broken open in a jar of hot vaseline (melting at 44° C.). Mixing is accomplished by melting and shaking after the jar has stood for twenty-four hours, and the contents are then tested for uniformity by fluorescence in the dark. Activity is checked by measurement of gamma rays emitted by the full jar before use.

Freshly prepared ointment is applied with a spatula to the lesion and a margin of about 1 cm. of healthy skin. A thickness of 2 to 3 mm. is most desirable. The ointment is covered by a rubber dam or cellophane. Applications are usually for eight hours and are repeated every week for a total of three or four applications.

Of 69 post-irradiational ulcers treated, 20 proved to be recurrences of the malignant lesion. Forty-one healed completely and 8 showed great improvement. Two typical cases are reported.

H. H. WRIGHT, M.D.